A MANAGEMENT PLAN FOR THE SOUTHERN JAMES BAY POPULATION OF CANADA GEESE

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EXECUTIVE SUMMARY

The Southern James Bay Population of Canada geese (hereafter SJBP) has been managed jointly by the Mississippi and Atlantic Flyways under a management plan developed in 1994. That plan was the first to use the SJBP designation for the group of geese formerly known as the Tennessee Valley Population (TVP) and it set objectives for 1994-1998. Since that plan was developed, a great deal of new knowledge of SJBP Canada geese and their ecosystems has been gained by the partners involved in research on and management of the SJBP. The purpose of this plan is to establish management priorities, determine research needs and promote action to properly manage the Southern James Bay Population (SJBP) of Canada Geese from 2001 onwards.

The decline in size of the SJBP witnessed in the late 1980s and early 1990s ceased during the 1994-1998 plan period and the population as a whole stabilized up to 2000, within our ability to detect change. The Akimiski Island portion (approximately 25%) continued a slow decline but the larger mainland portion grew modestly under the restrictive harvest management regime. In 1999, the SBJP reached its largest size in combination with the largest number of breeding pairs recorded in 11 years of spring surveys. The spring population objective in the new plan reflects this stabilization and the hope that the population can be maintained at this higher level. At the same time, the approach to harvest in the new plan reflects a desire to test how responsive the population is to harvest restrictions and whether the population can sustain increased use.

The spring population objective in this plan remains at the 100,000 bird level of the previous plan. Harvest regulations can be modestly liberalized in the current plan, subject to close monitoring. This will allow greater latitude in areas where growing giant Canada goose populations overlap with SJBP. A population model for use in projecting population changes as a result of management actions that affect harvest, survival and growth rates has been developed for use in monitoring population dynamics and response. Spring counts will be used for monitoring status and for use in annual discussions of harvest regulations. If the spring count remains near 100,000 within our ability to detect changes, then regulations can and should remain stable. If it falls below 85,000, regulation restrictions should be considered. Restrictive action can be taken in any single year, if the count is below 85,000, and consideration of other factors will be used in reaching a decision to restrict harvest. These include long term trend, any strong indications of a declining trend in recent years, unusual factors, estimates of productivity, observers' assessments of quality of spring survey, excessive harvest, disease outbreak, etc.

A review of accomplishments under the 1994-1998 plan is included, with comments on information products of flyway projects and those of partners and other researchers. A list of research and information needs for SJBP management is also included.

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Background

INTRODUCTION

The purpose of this plan is to establish management priorities, determine research needs and promote action to properly manage the Southern James Bay Population (SJBP) of Canada Geese from 2001 onwards. The SJBP is composed of Canada geese of the subspecies *Branta canadensis interior* which nest on Akimiski Island, Nunavut and on the southwestern James Bay coastal zone and interior muskeg of Ontario. The previous management plan (SJBP Technical Committee 1994) shifted emphasis for definition and status assessment of this population from wintering grounds to breeding grounds, while continuing to address management issues throughout the historic range. That plan was the first to use the SJBP designation for the group of geese formerly known as the Tennessee Valley Populations (TVP) and it set objectives for 1994-1998. Here we incorporate new knowledge of SJBP Canada geese and their ecosystems gained under the direction of that plan by the partners involved in research on and management of the SJBP.

The SJBP is currently characterized by the following features: 1) it is the smallest and most southerly breeding population of *B. c. interior*, 2) it migrates through and winters in two flyways, 3) a portion of the population traditionally reached a "deep south" terminus, 4) numbers of geese wintering in southern states have significantly declined, 5) direct recovery rates of banded juveniles from a significant portion of the range (Akimiski Island) are lower than adults, 6) recruitment and survival rates tend to be lower than other Canada goose populations.

The SJBP has faced considerable changes in land use activities on its migration and wintering grounds. Creation of northern waterfowl refuges and changes in weather and land use patterns are a few of the reasons hypothesized for distribution shifts occurring among states and flyways. Recent large increases in giant Canada geese (*B. c. maxima*) are also hypothesized to be affecting distribution and survival of SJBP geese and certainly have affected management via harvest regulations. In particular, the changes have made it difficult for managers to accurately assess the status and harvest of the population. This led to the shift of emphasis from wintering grounds to the breeding grounds for population definition and status assessment. Finally, new general knowledge about the interactions of geese and forage plant communities on breeding areas has highlighted the need for understanding the importance of breeding ground carrying capacity in the setting of population objectives.

Conservation of the SJBP is of special significance to many people. It is important that representatives from all people interested in SJBP management have input to the development and implementation of this plan. With full cooperation among managers and user groups, the goal of sustained wise use of the SJBP will be achievable.

DESCRIPTION AND HISTORY OF THE SJBP

The Southeast Population (SEP) of Canada geese was described by Hanson and Smith (1950:76) as that group of birds nesting in the southern tip of James Bay between the breeding range of the Mississippi Valley Population (MVP) to the north and west, and the South Atlantic Population to the north and east (Fig. 1A). It was suggested that the SEP wintered in small numbers throughout the southeastern United States of the Atlantic Flyway, mainly in the Piedmont region east and south of the Appalachian mountains (Hanson and Smith 1950:199). The Tennessee Valley Population (TVP) was first described by

Cummings (1973) as that segment of the SEP wintering in the Mississippi Flyway (Fig. 1B). Cummings (1973:2) suggested that Hanson and Smith (1950) recognized the TVP as a distinct segment of the SEP, however, no reference to this can be located. Subsequent to Cumming's work, the concept that the TVP was a segment of the SEP was lost for a short period. However, Bednarik and Lumsden (1977) then modified the definition of the TVP, stating that the TVP was synonymous with the SEP of Hanson and Smith (1950), except that the population had shifted to more discrete wintering areas. Therefore, based largely on breeding ground (Akimiski Island) banding and recoveries throughout the fall and winter hunting seasons, they enlarged the geographic range of the TVP to an area similar to that described for the SEP by Hanson and Smith (1950), and including parts of both the Mississippi and Atlantic flyways (Fig. 1C). Moreover, Bednarik and Lumsden (1977) showed that Canada geese breeding on Akimiski Island in James Bay were wintering in both flyways. The SJBP, including mainland birds, still have a similar overall migration and wintering distribution (Smith *et al*. 1992, Trost *et al*. 1998).

Breeding grounds definition

The definition of breeding range for a widespread and continuously distributed subspecies like Interior Canada geese in the Hudson Bay Lowland is problematic. In theory, the subspecies could comprise one large population. However, breeding ground banding has shown clearly that there is non-random distribution of migration and harvest of *B. c. interior* Canada geese along a longitudinal continuum in the states and provinces of the Mississippi and Atlantic Flyways (Hanson and Smith 1950, Vaught and Arthur 1965, Wright and Kasul 1984, Samuel *et al*. 1991). These longitudinal discontinuities originally gave rise to the EPP, MVP, TVP and AP population designations based on winter units. This is a pragmatic approach which recognizes that population management is driven by harvest management and that it must make sense of the preponderance of distribution of harvest of birds throughout the year. Therefore, migration and winter distribution modifies purely breeding grounds criteria for population definition. Despite the shift in population status *assessment* to the breeding grounds (reflected in re-naming the population the SJBP), in this plan we adhere to the historical approach of defining total range to facilitate harvest management.

The breeding grounds of the SJBP are best delineated by banding of flightless adults accompanied by pre-fledging goslings. Since 1971, TVP/SJBP targeted banding has focused mainly on Akimiski Island and the Ontario mainland coastline from the Quebec border near the southern tip of James Bay to the Attawapiskat River at the north-south mid-point of the west coast of James Bay. Interior muskeg banding in southwestern James Bay is negligible. No modern banding (i.e., since 1958) has taken place on the other islands of James Bay or the Quebec coast of James bay adjacent to the Ontario border. There has historically been difficulty in determining the northern and eastern boundaries of the breeding range. However, MVP targeted banding in the 1990s along the Ontario mainland coastline of northwest James Bay has filled gaps at the northern edge of SJBP range. Analysis of all available banding (J. Kelley, USFWS, unpublished MRPP, February 2000) holds promise for more clearly defining the geographic scope of the breeding range of both populations along the James Bay coast of Ontario.

At a January 1989 SJBP workshop in Lansing, Michigan, the following working definition of breeding range was proposed based on then current knowledge of breeding ground banding: "The SJBP consists of breeding birds from Akimiski, Twin and Charlton Islands, N.W.T., the James Bay coast from Ekwan Point, Ontario, south to Moosonee and east to the Ontario-Quebec border, then north along the Quebec James Bay coast to 53^{o} 30' latitude." (MFCTS minutes, Little Rock, AR, Feb. 1989). The southern limit of the breeding range was proposed to be 50^{o} 00' N latitude.

The initial breeding ground survey in 1990 consisted of 51 transects measuring 10 km X 0.5 km; 24 lines were located on Akimiski Island, and 27 on the mainland. Additional transects were added in 1991 in an

effort to reduce variance of the estimates; 28 lines were flown on Akimiski, and 48 on the mainland that year. The coefficient of variation dropped from 18.8% in 1990 to 13.5% in 1991. In 1992, experimental surveys were flown on the mainland south of the original survey boundaries to determine the southern extent of the breeding range. The survey area was subsequently enlarged to extend to 50° 00'N latitude, but excluded the area from there south to the edge of lowland habitat because few pairs were found and the expense was inordinate for the information gained (Leafloor 1992). The numerical consequences to the population estimate are negligible. However, the biological and migratory affinity of these few geese nesting at the southern edge of Hudson Bay Lowland habitat is most likely to the SJBP. Charlton Island was also surveyed that year, but fewer than 400 nesting birds were estimated to occupy the island, and additional surveys have not been attempted there. Again, the significance of this exclusion in terms of population size is not large. The biological and migratory relationship between these birds and that portion of the SJBP that winters in the Atlantic Flyway remains unclear. In 1993, the mainland survey area was again enlarged, and 5 additional transects were added to include the area between the Albany and Attawapiskat Rivers extending inland to 84°W longitude. Population estimates were revised to account for the enlarged survey area (Leafloor 1992), and the survey has remained consistent since then.

The SJBP breeding range now surveyed annually includes Akimiski Island, Nunavut and the Ontario mainland from 52° 58' N, 82° 17' W (the mouth of the Attawapiskat River) west to 84° 00' W longitude, south to 50° 00' N latitude, and east to the Ontario-Quebec border (approximately 79° 30' W longitude, Fig. 2).

Additional background information on the SJBP can be found in Hanson and Smith (1950), Cummings (1973), Bednarik and Lumsden (1977), Raveling and Lumsden (1977), Kasul and Wright (1984), Leafloor *et al*. (1996), Leafloor *et al*. (2000), Orr *et al*. (1998), and Trost *et al*. (1998).

Summaries of annually collected data, both historical and current, are found in the plan Appendices (Fig. 1-7, Tables 1-7). These will be updated and supplemented during the course of the planning period as the plan is seen as a "living" document.

REVIEW OF 1994-1998 PLAN ACCOMPLISHMENTS

The 1994-1998 plan established objectives and specific tasks to accomplish them. Much work was conducted on SJBP geese and a great deal of new information was obtained to assist managers. This section is a quick checklist of the status of each task for each plan objective. More comprehensive discussion occurs in the related rationale statements for the new plan.

1994-1998 Population Objective

A spring population of 100,000 SJBP geese by 1998, as measured by the spring breeding ground survey. The spring population average met the objective over the period as a whole. The average for 1994-1998 was 104,965 and it was above 100,000 in 2 of the 5 years. The average for 1994-2001 was 103,799 and it was above 100,000 in 4 of the 8 years.

Strategy A: Monitor annual spring population size, productivity and survival.

Task 1. Conduct annual spring breeding ground survey.

The spring survey was conducted in all years. Timely reports by Jim Leafloor and Ken Ross were provided for all summer meetings.

Task 2. Measure factors of productivity on SJBP breeding grounds.

Annual productivity was measured on Akimiski Island, including total clutch size, clutch size at hatch, goslings leaving the nest, and age ratios at banding (goslings/breeding female). On the mainland, only the last was measured. Publications include: Leafloor *et al*. 1997, Badzinski 1998, Hill 1999, and Leafloor *et al.* 2000.

Task 3. Monitor survival rates and distribution of harvest.

Leg-banding and neck-banding was conducted annually on Akimiski Island and the mainland.. Previously unbanded or infrequently banded areas were not visited. Neck band observation networks were not maintained, but harvest derivations were calculated annually (D. Rusch and J. Wood, USFWS, unpublished) and analysis of neck band observation and leg band recovery distribution was begun (A. Smith, USFWS, unpublished). The low gosling direct recovery rates were investigated with research on Akimiski Island (Hill 1999). Publications include: Leafloor *et al.* 1996, Trost *et al.* 1998, Hill 1999.

Task 4. Monitor disease and non-hunting mortality.

There were no reports of neck band related mortality, and no reports of disease outbreaks affecting SJBP during the plan period. Samples were collected (Badzinski 1998) for examination of renal coccidiosis, however, analysis has not been done. A study was conducted on pre-migration mortality in 1999 and 2000 (K. Patton, thesis analysis in progress 2001).

Strategy B: Annually develop and implement hunting regulations consistent with the 100,000 spring population objective and the harvest management strategy.

Harvest regulation actions were determined annually by consensus during the 1994-1998 plan period; regulations did not conform to the triggering population levels in the plan's harvest strategy for a variety of reasons. These included a decline in the number of breeding birds, anticipated negative effects on recruitment of new breeders resulting from increased harvest on sub-adult birds, suspected poor survival of goslings to fledging, and concerns about habitat degradation on Akimiski Island.

Task 1. Delineate SJBP harvest areas for each state and province.

All states and provinces delineated SJBP harvest areas.

Task 2. Monitor the impact of sport harvest on SJBP geese and develop and refine a harvest management strategy.

Don Rusch and co-workers (unpublished) conducted a harvest rate analysis which showed lower harvest rate in the 1990s and 1970s than the 1980s. Harvest derivations were calculated using spring population survey information updated annually. A harvest rate objective was not developed (but see Appendix C).

Task 3. Monitor and evaluate the effect of special seasons on the SJBP.

States evaluated their special seasons including Michigan (Soulliere, *et al.* 1988, Martz and Soulliere 1991, Soulliere and Martz 1997), Ohio, Indiana , and Pennsylvania, however, no comprehensive flyway wide analysis of the effects of special seasons was conducted.

Task 4. Develop a model to predict fall flights of SJBP geese.

No model of fall flight was developed, however, a model incorporating known estimates of SJBP biological and harvest parameters was developed to guide regulation and management discussions (see Appendix C).

Strategy C: Work co-operatively with Natives to ensure their participation in SJBP management and in monitoring their harvest.

Several meetings between council committees and other management agencies (CWS, OMNR) were held with Natives of the Mushkegowuk First Nations. First Nations hunters re-directed spring harvest pressure from Akimiski Island to the northwest James Bay coast, and to snow geese as a cooperative move to reduce pressure on SJBP. The 2001 plan was reviewed by the First Nations chiefs and they were basically satisfied with the plan.

Task 1. Monitor the magnitude and distribution of subsistence harvest of SJBP geese.

No First Nations goose harvest survey was conducted during the plan period. The most recent previous survey (conducted by university based researchers with Canadian federal government support in 1990-1991) was published during the plan period (Berkes *et al*. 1994).

Distribution Objective

Maintain a Mid-December population of at least 40,000 SJBP geese in Kentucky, Tennessee and Alabama, and a January population of 8,000 SJBP geese in North and South Carolina. This objective was not met during the 1994-1998 plan period. The average mid-December index for these states for 1994-1997 was 19,515 with a decline of over 50% from the beginning to the end of the period. However, surveys in the winter of 2000-2001 showed record numbers of total Canada geese in some areas (Kentucky, Tennessee) most likely due to high snow fall and severe cold in northern states and Ontario in December.

Strategy A. Monitor SJBP distribution and migration chronology.

Task 1. Conduct migration and wintering ground surveys in mid-December and early January.

December counts were conducted through 1997, but the Mississippi and Atlantic Flyways' standard count was changed to January in 1998 and only some states continued the December counts (e.g., Indiana does a count but it is restricted on state and federal refuge areas). The related task of determining population specific composition of wintering flocks (i.e., MVP, SJBP, AP, giants/residents) was not done. However, investigation of the development of genetic analysis from harvest survey parts as a population harvest derivation technique is ongoing for Michigan and elsewhere (K. Scribner and H. Prince, unpublished).

Task 2. Conduct surveys, banding, neck banding and/or telemetry to address management issues concerning segments of the SJBP.

Analysis of the leg-banding and neck-banding program was begun (A. Smith, USFWS).

Task 3. Monitor giant Canada goose breeding population size, distribution and harvest in SJBP range.

Giant Canada goose management was formalized in both the Mississippi Flyway and Atlantic Flyways with management plans (Mississippi Flyway Giant Canada Goose Committee 1996, Atlantic Flyway Canada Goose Committee 1999).

Strategy B: Implement special regulations as a means of protecting and possibly restoring southern segments of the SJBP.

Task 1. Consider special regulations to assist in restoring the southern segment of the SJBP.

All states had restrictive regulations and closures occurred in some southern states. Analysis of affiliations of southern wintering geese to northern states' staging and harvest areas was begun. No experimental special regulations to restore southern segments were undertaken.

Habitat Management Objective

Ensure adequate food, water and protection on nesting, migration and wintering areas consistent with the population habitat status and landowner tolerance.

Strategy A: Monitor habitat, potential development projects and other threats to ensure protection of nesting habitat.

Task 1. Conduct habitat inventory to classify important nesting areas and identify areas of concern.

The entire nesting range of the SJBP was classified using remote sensing and ground truthing (A. Jano, OMNR, unpublished). An analysis of vegetation change on the north shore of Akimiski Island, an area of concern, was also undertaken (Hudson Bay Project, unpublished).

Task 2. Encourage aboriginal groups, the Canadian Wildlife Service and the Ontario Ministry of Natural Resources to ensure the protection of SJBP breeding grounds from disturbance.

A change in status of a key part of the breeding range occurred on April 1, 1999 when the new Nunavut Territory was declared as part of the Nunavut Land Claim Settlement. The Nunavut Territory includes all James Bay islands, but as the islands are not part of the Nunavut Settlement Area, wildlife management in this zone of Nunavut (Zone 2) remains a joint responsibility of Nunavut and the "designated agencies" (in this case, Environment Canada, Environmental Conservation Branch, Canadian Wildlife Service). Thus, the Canadian Federal Migratory Bird Sanctuary remains as it was on Akimiski Island. No changes in the status of the Ontario breeding range occurred. Although no major industrial developments took place, one diamond mining exploration site was occupied throughout the plan period in the interior mainland, approximately 100 kilometers west of Attawapiskat. In addition, as part of a rural electrification plan, a corridor for electricity transmission lines was cut adjacent to the existing winter road which traverses the Lowland from Moosonee to Attawapiskat roughly parallel to the James Bay coast (but somewhat inland, not immediately at the coast).

Task 3. Conduct an evaluation of brood habitat on Akimiski Island.

An investigation of Akimiski salt marsh habitats was conducted from 1993-2000. The north shore was identified as an area of degraded habitat (Abraham and Jefferies 1997, Hudson Bay Project, unpublished).

Strategy B: Conduct habitat inventories every 5 years of all significant SJBP migration and wintering areas, and increase components as needed to aid in achieving the population objective.

As recommended, the habitat inventory has been updated for the new plan.

Task 1. Evaluate habitat management practices at key SJBP areas, to determine if resources are sufficient to provide adequate food, water and sanctuary.

No comprehensive evaluation was undertaken.

Management Plan 2001

This plan sets a goal, objectives and strategies for the management of the SJBP in states and provinces of the Atlantic and Mississippi Flyway Councils. The involvement of the U.S. Fish and Wildlife Service, the Canadian Wildlife Service and Ontario First Nations, in addition to state and provincial wildlife management agencies, is critical to the successful implementation of the plan. The focus of the management plan is to gather information needed to manage this population wisely with conservation as the first principle, to contribute to maintenance of the genetic diversity of Canada geese, to provide for subsistence harvest, to provide for hunting opportunities and harvest, and to provide for aesthetic appreciation and viewing opportunities. This plan will be revised as new information warrants, according to the direction of the Flyway Councils, and information tables will be updated annually.

SJBP Management Goal:

TO MAINTAIN THE SOUTHERN JAMES BAY POPULATION OF CANADA GEESE AT A LEVEL THAT CAN SUSTAIN USE THROUGHOUT ITS CURRENT RANGE

OBJECTIVE I. POPULATION SIZE.

Maintain a spring population of 100,000 SJBP Canada Geese as measured by the annual spring breeding ground survey.

Rationale: Surveys in 1985 and 1990-1993 indicated a major decline on the Akimiski Island portion of the breeding range from approximately 76,000 to a low of about 21,000 in 1993. No pre-1990 mainland estimates are available to ascertain whether a similar decline occurred in that portion of the range (Leafloor *et al*. 1996), however, indications from winter counts in both flyways strongly indicate a corresponding decrease of the SJBP overall (Orr *et al.* 1998). The 100,000 bird objective for the 1994-98 plan was chosen because of this apparent dramatic decline and also because it was thought to be attainable (ca. 10% growth), using restrictive harvest regulations compared to the 1980s. The overall spring population size of the SJBP has ranged from a low of 77,346 in 1993 to a high of 136,623 in 1999 (Table 1) and the average was 89, 850 (1990-1993), 104,965 (1994-98) and 103,799 (1994-2001). The plan objective was reached in 2 of 5 years between 1994 and 1998 (and 4 of 8 years between 1994 and 2001). Growth of the SJBP overall has averaged 4% per year. The sustained growth indicates that a modest increase in hunting opportunities and harvest is possible, while maintaining the population near 100,000. Thus, the objective for 2001 and beyond is to keep the spring population near 100,000. The number of breeding pairs and the proportion of breeding birds in the spring population as measured by the annual spring survey should also be monitored closely. Significant decreases in percent breeders should be a concern and will be considered in annual regulations discussions.

Strategy I. A. Monitor annual spring population size, productivity, and survival.

Task I. A. 1. Conduct an annual spring breeding ground survey and continue to explore means of improving accuracy and precision of population estimates.

Rationale: Spring population surveys of SJBP Canada Geese have been conducted annually since 1990. The estimates are used in calculations of harvest derivations and they provide critical information about population status and breeding effort in different portions of the range. Numbers of geese on Akimiski Island have been relatively stable since 1991 (Table 1); breeding pairs have ranged between about 7,000 and 11,500 pairs during that time, but numbers of non-breeding birds have fluctuated between 5,400 and 24,000 individuals during the same period. Numbers of mainland breeding pairs ranged from a low of about 14,500 in 1994 and a high of 42,500 in 1999 (Table 1). Non-breeding geese ranged from 3,200 to 35,600 during that period. Large fluctuations in non-breeding geese have been attributed to influxes of molt migrants from southern giant Canada goose populations (Abraham *et al*. 1999) before surveys began in some years. Currently, timing of survey is aimed at avoiding the influx of molt migrants, thus giving a more repeatable index of SJBP size. Location of transects and mean breeding pair and non-breeding bird densities on each transect for 1990-1999 are shown in Fig. 3 and Fig. 4, respectively.

As noted in the description and history section, there has always been uncertainty about the northern extent of the breeding range for SJBP Canada Geese. Traditional descriptions of migration and wintering areas have been based largely on band recovery distributions of birds banded on Akimiski Island. Mainland areas with recovery distributions similar to Akimiski Island were included in the SJBP breeding range, but relatively few geese were banded in mainland areas before the early 1990s. Increased banding efforts in northwestern James Bay, an area traditionally included in the breeding range of the MVP, have yielded additional information on recovery distributions of geese from that area which suggest that some geese banded in northwest James Bay are recovered in SJBP migration and harvest areas. More detailed analysis will be required to determine the proportion of SJBP area versus MVP area recoveries and whether current range boundaries between the MVP and SJBP require revision. Subsequently, this could result in adjustments to the spring survey, resultant population estimates and the appropriateness of the spring population objective.

Task I. A. 2. Measure annual productivity on SJBP breeding grounds.

Rationale: Understanding factors that influence variation in annual production of goslings is essential for proper management of the SJBP, because harvest should not exceed production in a given year if a stable or increasing population is desired. The number of young in the fall flight is calculated as a product of the number of nesting pairs, nest success (i.e., proportion of nests hatching at least one egg), the average clutch size at hatch in successful nests, and gosling survival to fall migration (Malecki and Trost 1998). Research on nesting biology and gosling survival on Akimiski Island has been conducted annually since 1993 and information on age ratios at banding (goslings/brood patch female) has been collected annually since 1984. These data provide an annual index to gosling production for the SJBP, but are not without limitations (see below).

Age ratios at banding: Banding occurs in coastal areas of the SJBP breeding range and focuses on the capture of locally nesting adults and their broods; flocks composed entirely of adults are avoided so that as few as possible molt migrant Canada Geese are banded. Brood patches on adult females indicate a nesting attempt in that year (Hanson 1959) and records of brood patches are kept for all adult females captured. This allows calculation of the number of goslings per brood patch female, an index of average brood size at banding. If unsuccessful females (i.e., those that have lost their nest or entire brood) are captured with brood flocks in proportion to their occurrence in the population, the index should provide a reasonable estimate of production. However, if unsuccessful females depart from nesting areas or flock independently of successful females, then the index over-estimates production. Conversely, if failed

breeding female molt migrants are not excluded the index under-estimates production. This type of index also does not account for gosling mortality that occurs after banding, but before hunting seasons begin, and thus may not adequately reflect size of the fall flight (see below).

Akimiski Island Productivity Study: A study of nesting biology and gosling survival began on Akimiski Island in 1993 to investigate possible reasons for the decline in numbers of Canada Geese on the island since 1985. Each year, data are collected on nesting chronology, clutch size, nest success, hatching success, and gosling survival to banding. These data suggest good production of goslings in most years (except 1996), but gosling survival estimates to banding age do not include an estimate of total brood loss, and are therefore likely to be biased high. As with age ratios at banding, these data do not account for mortality that occurs after banding, but before migration.

Post-banding Survival of Goslings on Akimiski Island: Canada Geese nesting on Akimiski Island have not increased substantially in number over the past decade (Table 1), despite restrictive harvest regulations implemented since 1991. This suggests that factors other than harvest (such as habitat condition) may be influencing population dynamics of geese on the island. Direct recovery rates (DRR) of Canada Geese banded as goslings on the island have been very low since 1987 (averaging 1-3%; other populations of *B. c. interior* usually average 5-8% DRR for juveniles). In addition, field personnel commonly find bands from juvenile birds in the spring following banding. Low direct recovery rates of goslings are likely related to declines in habitat quality. Hill (1999) found that the smallest goslings banded were rarely recovered, and that most recoveries were goslings of above average size at the time of banding. Preliminary results from a study undertaken in 1999 and 2000 (K. Patton, unpublished) suggest that gosling mortality after banding, but before fall migration, can be substantial. In 1999, of 107 goslings marked with radios at banding (approximate age 45 days), at least 65 (61%) were known to have died prior to fall migration. Although preliminary results from 2000 suggest better survival (approximately 35% died), this suggests that on Akimiski Island at least, productivity indices determined at the time of banding, if used in a model of fall flight, would be biased high. Similar studies on the mainland would be desirable, albeit logistically difficult because of lower densities of nests and lack of concentrations of broods.

Task I. A. 3. Monitor survival rates and distribution of harvest.

Rationale: Biologists have long assumed that harvest controls survival, which in turn controls population growth in Canada geese (Rusch *et al*. 1996). Harvest rates and survival rates estimated from band recoveries suggest that hunting accounts for most of the mortality in adult Canada geese. Thus, operational banding (both leg-banding and neck-banding) is important for providing long-term information about survival rates, productivity, distribution of harvest, and other population parameters essential to properly manage geese. Annual banding also allows managers to distinguish between closely related Canada goose populations. Without visual marking, the ability to distinguish between individuals from different goose populations is not possible during ground surveys. Distinguishing between populations has become even more difficult due to the increasing numbers of giant Canada geese, and mixing of these populations throughout the range of the SJBP.

Geese have been banded annually on Akimiski Island since 1976. Geese have also been banded annually on the mainland in the region between Fort Albany and the Ontario/Quebec border since 1985. Smith *et al*. (1992) and Trost *et al*. (1998), analyzed recovery rates, survival rates and recovery distributions of banding through 1990 and 1987, respectively. Differences between adults and immatures subgroups were detected, but varied in significance and interpretation. Differences in direct recovery distributions were suggested to be a result of higher vulnerability of juveniles in the northern part of the range. Differences in over-all range of recoveries were minor, but inclusion of Giant Canada goose molt migrants banded on SJBP breeding areas could account for most of these. Analysis of data through 1996 showed these

differences in adult and juvenile recovery and survival rates persisted, with juvenile rates significantly less than adults (A. Smith, unpublished). Juvenile survival rates based on band recoveries averaged 29.8% (1986-91) and 25.6% (1992-96). Adult survival rates during the same time periods averaged 68.2% and 69.3%, respectively. Analysis of survival from neck-banded birds indicated that adult survival rates declined during the 1992-96 period when compared to the previous 5 year period. We recommend that leg-banding, neck-banding, and subsequent analyses continue on an operational basis. Future banding should maintain banding sample sizes in traditional areas sufficient for survival analyses, but also target previously unbanded or infrequently banded regions (especially the mainland). The objective of the banding program should be to determine survival rates for all segments (juvenile/adult, island/mainland) of the SJBP.

Annual leg-banding and neck-banding of giants and neck band observations of both giants and interiors, should also continue in all SJBP states/provinces to help delineate populations that overlap during significant portions of the annual cycle. For Canada goose management to be successful in the circumstances which now exist, it must supercede state and flyway boundaries (Trost *et al*. 1998) and deal with all co-existing populations.

Task I. A. 4 Monitor disease and non-hunting mortality.

Rationale: The importance of disease and other forms of non-hunting mortality in the population dynamics of SJBP Canada geese is not known. Predation, disease, accidents and other forms of non-hunting mortality account for only 14% of the total mortality of adult Canada geese (Rusch *et al*. 1996), however, it may be higher for juveniles. Estimates of Akimiski Island gosling survival from hatch to banding in late July (ca. 45 days) range from 60-75% (Leafloor *et al*. 2000), which is somewhat higher than that reported for MVP geese (59%; Bruggink *et al*. 1994) and considered good for most wild populations. However, the low juvenile annual survival rates (25-30%) is a cause for major concern. Poor body condition of goslings related to declining habitat quality has resulted in increased post-banding mortality in other goose populations (Williams *et al*. 1993). Much of the brood rearing habitat on the north shore of Akimiski Island has been severely degraded by intensive foraging activities of geese and it is hypothesized that this is related to the high mortality in the post-banding (see rationale for Task I. A. 2 above). However, its connection and possible interactions with physiological stress or disease complications of weakened birds is unknown and should be investigated. Although there is currently no indication of any unusual or extraordinary disease effects in the SJBP, monitoring should be conducted and appropriate action taken if the situation warrants. It is imperative to any SJBP population model or harvest strategy to identify and understand the dynamics of any source of significant non-hunting mortality.

Strategy I. B. Develop and implement hunting regulations consistent with the spring population objective of 100,000.

Rationale: Harvest regulations should be driven by the spring population objective of 100,000. For 2001 and beyond, the harvest strategy will be to permit *modest* liberalization from the 1993-2000 regulations. The new regulations should remain stable for the plan period if possible, as the intent is to gain experience with population levels, harvests and growth under a slightly more liberal regulations environment. A prescriptive approach to regulations (i.e., regulations actions pre-determined by reaching spring population thresholds) will not be used. During the 1993-2000 of stable regulations, spring population counts and annual total harvest estimates varied widely, but not in concert, indicating little fine-scale correspondence to harvest or regulations. In addition, the technical committees and flyway councils found mitigating circumstances throughout that period which over-rode strict adherence to the pre-determined prescriptions.

The spring population estimate will be the primary index used to determine status and need for regulation changes. Review of regulation changes will be done annually, but longer term trends should be considered when regulations are recommended. We should try to avoid changing regulations frequently in an attempt to influence or take advantage of short term changes in population levels. Decisions would be made through negotiations each summer. With significantly increased populations, all jurisdictions would be permitted to take advantage of more liberal harvest. In moderately declining populations, the major jurisdictions would effect the control necessary. If the spring population estimate is below 85,000, restrictions in regulations should be considered. However, in extreme declining populations, all jurisdictions would have to make appropriate restrictions. This is in concert with the EPP strategy and the draft MF harvest strategy. This does not preclude lesser harvest jurisdictions from considering regulations that would promote additional protection for geese that arrive early at southern terminal wintering areas, which is consistent with the new SJBP Plan.

In the development of liberalized regulation packages in any jurisdiction, analysis of harvest, harvest rate and growth rate expectations must be incorporated (changes should have expected impact of <10% increase in harvest). The liberalization will permit increased hunting opportunity, easing of restrictions where growing populations of giant Canada geese are a problem, gathering new information on bird distribution and harvest, and evaluation of whether the SJBP can sustain increased harvest without incurring destabilizing declines in growth rate.

Ideally, the goal of this management approach is a growth rate of no less than 1.0 with population near the objective level and more liberal regulations. In proceeding with liberalization, the implicit hypothesis being tested is that the population growth experienced since 1991 is the result of factors other than or in addition to restrictive regulations (e.g., buffering by giants). If the growth rate of recent years continues, this hypothesis can be supported, however, if the growth rate slows, then the hypothesis can be rejected.

The guidelines should apply to SJBP harvest areas as defined by the SJBP Committee, the Atlantic Flyway Canada goose committee, the USFWS and the Canadian Wildlife Service. These include portions of Ontario, Michigan, Indiana, Ohio, Pennsylvania, Kentucky, Tennessee, Alabama, North and South Carolina.

Task I. B. 1. Delineate SJBP harvest areas for each state and province.

Rationale: In modern goose management strategies, population-specific estimates of harvest are needed to monitor the effectiveness of regulation changes, and how these changes affect goose populations. In recent years, managers have used analysis of weighted band recoveries to calculate the derivation of the Canada goose harvest in each state and province (D. Rusch and J. Wood). The method requires that the size of each population is reasonably estimated, that a representative sample of the population is banded, and that band recoveries are produced during the entire hunting season. The weight per band recovery (i.e., how many birds each recovered band represents) is a proportion of the number of bands available divided by the estimated number of birds in the population. The number of bands available is estimated from the number of bands recovered divided by the harvest rate. Harvest rate is the direct band recovery rate divided by 0.33, the assumed band reporting rate (Rusch *et al*. 1996).

Up-to-date delineation of harvest areas and SJBP concentration areas is important for harvest management. This has been completed for the Atlantic Flyway (Appendix E) and SJBP concentration areas should be delineated for the Mississippi Flyway from updated band recovery data sets (e.g. Fig 5, cf. Smith *et al.* 1992).

These data should be used by each state and province to define areas where SJBP harvest regulations will apply. SJBP Zones should collectively include at least 70 percent of the SJBP recoveries in the state/province.

Task I. B. 2. Monitor impact of hunter harvest on SJBP geese and develop and refine a harvest management strategy.

Rationale: To determine the impacts of regulations, hunter harvest of SJBP must be correctly estimated. Annual harvest estimates need to be refined to allow apportionment of the harvest among the different Canada goose populations (using an estimate of harvest and/or harvest rates), and to accurately assess age ratios of harvested geese. A method to measure harvest rate for the population as a whole and for each state/province should be developed, as well as an appropriate harvest rate objective. In concert with the harvest management strategy, these can help ensure attainment of the population objective. Serious regulation restrictions took place in 1993, but there has been no consistent reduction (often a large increase) in harvest for any state or province (Table 3). In future, management actions such as these must be monitored carefully to determine that the desired effect is being achieved.

Task I. B.3. Monitor and evaluate the cumulative effect of special seasons on the SJBP.

Rationale: Several SJBP states and Ontario have special early or late goose seasons aimed at reducing numbers of giant Canada geese. Guidelines established by the USFWS for special seasons in the US restrict the harvest of interior Canada Geese to no more than 10% and 20% of the total harvest during these early and late seasons, respectively. The cumulative harvest of SJBP geese should be closely monitored and the impact of these special season harvests, both positive and negative on SJBP population growth, should be evaluated on a comprehensive basis (Bowers, in progress).

Task I. B. 4. Test and refine a model to predict changes in numbers of SJBP geese under different management alternatives.

Rationale: Population models are increasingly being used as decision support tools in goose management. The primary model application identified for SJBP management is establishing harvest rates that are consistent with population objectives. One advantage of using population models in harvest management is the ability to project population responses to harvest over a variety of time scales. This may be significant for interior Canada geese because delayed sexual maturation can create time lags of several years between harvest decisions and responses in breeding population numbers. If relationships between regulation options and harvest rates are defined, then regulations could be linked to population surveys and model projections to achieve desired population trajectories. Another benefit of using models is synthesis and testing of existing knowledge on SJBP population dynamics to identify future research needs. A SJBP population model has been developed in coordination with the Mississippi Valley Population Canada Goose Technical Committee. The preliminary model, including harvest and growth rate simulations is documented in Appendix C. It should be tested annually with new information and refined to improve its usefulness during regulations discussions.

Strategy I. C. Work co-operatively with Cree First Nations to ensure their participation in SJBP management and in monitoring aboriginal harvest.

Rationale: Coordination of SJBP management with aboriginal people and sharing information on SJBP status, current research, management efforts, harvest levels and reporting are very important to reaching the plan objectives. A strong commitment to cooperation among all users of the SJBP is necessary to ensure the successful implementation of this plan.

Task I. C. 1. Monitor the magnitude, spatial and temporal distribution of aboriginal harvest of SJBP Canada geese.

Rationale: The majority of Cree First Nations people in the Hudson Bay Lowland of Ontario and James Bay live within the nesting and migration areas of the SJBP. Consequently, SJBP Canada geese have historically been taken for subsistence in larger numbers than geese of the MVP, EPP, TGPP and Atlantic Population (Prevett *et al*. 1983). Aboriginal harvest has been estimated approximately once per decade since the 1970s. The recent increase in Giant Canada geese in the Hudson Bay Lowland before and after molt has attracted aboriginal hunters in the 1990s (John Turner, pers. comm.) but the number of Giants taken is unknown. Also unknown is the potential for any unintended increase in SJBP kill during hunts targeted at Giants. Aboriginal subsistence harvest of geese should be considered when the population is modeled and when harvest management strategy is debated to ensure continued use for all interested parties. During the plan period 1994-1998, no surveys of subsistence kill in the Hudson Bay Lowlands were undertaken, although the results of a 1990-91 survey were published (Berkes *et al*. 1994). The last analysis of population derivation of subsistence kill was in the mid 1970s, well before the decline of SJBP and the increase of Giants. An updated aboriginal harvest estimate by goose population is a high priority, preferably in 2001 or 2002 (10 years since the last survey). In reviewing this plan, chiefs suggested working to include an information section which describes their harvest and outlines some of the traditional rules that govern their hunt.

OBJECTIVE II. DISTRIBUTION.

Increase the January population in Kentucky, Tennessee and Alabama to 130,000 total Canada geese and in North and South Carolina to 8,000 SJBP geese (based on 1985-89 or pre-decline averages).

Rationale: Historically, large numbers of the SJBP wintered in Alabama, Tennessee, Kentucky, North Carolina and South Carolina (Fig. 6). These numbers have declined over the past two decades and wintering SJBP geese on Wheeler NWR (Alabama) and Cross Creeks NWR and Tennessee NWR (Tennessee) have declined dramatically in recent years (Fig. 7a, 7b, 7c). Suggested factors responsible for the migration timing and destination of these birds include the influence of mild winters, changing farming practices and the effects of range-wide giant Canada goose increases. It is desirable to attempt to reverse the decline and restore the SJBP in the southern part of their range as part of the overall management plan, although the means necessary to achieve this are unknown.

Strategy II. A. Monitor SJBP distribution and migration chronology.

Task II. A. 1. Conduct migration and wintering ground surveys in early January.

Rationale: Mid-December (Table 4) and Mid-Winter (January) (Table 5) surveys were once the only indices of population size for SJBP geese . With the large increase in giant Canada geese, these surveys now provide unreliable estimates of SJBP population size. However, the January survey should continue in all Mississippi and Atlantic flyway states with a history of SJBP use to monitor distribution and migration chronology. As these counts yield only total Canada geese, a critical need exists to improve population derivation methods, using neck bands or other techniques, to increase accuracy in determining population affiliation and turnover throughout the winter season.

Task II. A. 2. Develop research to identify if a cohort of SJBP can be managed to increase the number of birds wintering in "deep south" states such as Alabama and the Carolinas. Research should also address a range of potential explanations for declines in wintering SJBP in the south.

Rationale: The SJBP is one of the few Canada goose populations that maintains a "deep south" migration tradition. However, this tradition appears to be diminishing (Table 5, Figs.6, 7) and there is merit to investigating the potential of managing this group of geese as a distinctive cohort. Of special concern has been the hypothesized existence of an early migrating cohort of interior geese (termed "homers") that could be vulnerable during special early seasons in northern states and provinces (Orr *et al*. 1998). However, five years of research with radio-tagged interior geese failed to demonstrate any fall-fall homing between early or late migrants among geese that spent the fall at various southern Illinois refuges (Tacha 1989). The lack of homing among early migrants found in these studies could also apply to SJBP geese, but this idea should be tested. Examining research methodologies used in the MVP study would be a good starting point in developing new research. Tools such as satellite telemetry should be explored to better define migration corridor use and migration chronology, especially for wintering segments of concern, such as SJBP geese in Alabama, Tennessee and the Carolinas. Habitat trends, harvest trends and climate change should also be investigated as possible reasons for diminishing numbers of southern migrating geese.

Task II. A. 3. Monitor Giant Canada goose breeding population size, distribution, and harvest in SJBP range.

Rationale: Increases in the giant Canada goose population in both the Mississippi and Atlantic flyways have greatly confounded goose population management (Mississippi Flyway Giant Canada Goose Committee 1996, Atlantic Flyway Canada Goose Committee 1999). Key information should be collected where possible, including breeding population size, estimated production, estimated harvest and methods of discriminating giants from other races in both the harvest and winter surveys. Numbers and impacts of molt migrant giants on the SJBP breeding grounds and brood rearing habitat also should be assessed.

Strategy II. B. Investigate special regulations as a means of protecting and possibly restoring southern segments of the SJBP.

Task II. B. 1. Consider special regulations to assist in restoring the southern segment of the SJBP.

Rationale: Special regulations might be developed to aid in the restoration of southern SJBP segments. Analysis is needed to determine whether changes in harvest and harvest rates at specific southern terminus locations and/or range-wide have been coincident with changes in SJBP numbers in southern areas. Included is a need to demonstrate that a manageable southern cohort exists. One possibility for special regulations in southern areas is delaying harvest in Kentucky, Tennessee and Alabama until major flights of late-arriving geese have arrived (after Dec. 15) to buffer harvest impacts on early-arriving geese (before Dec. 15). Another action is to close or keep closed Canada goose hunting in western counties of North and South Carolina until SJBP populations in those states increase substantially over present levels.

OBJECTIVE III. HABITAT MANAGEMENT.

Ensure adequate food, water and protection on nesting, migration and wintering areas consistent with population objectives, habitat status and landowner tolerances.

Habitat conditions throughout the nesting, migration and wintering areas vary from year to year and can have a great effect on the health and status of the SJBP. Therefore, it is necessary to monitor and periodically evaluate the status and condition of nesting, migration and wintering areas important to the SJBP.

Strategy III. A. Monitor habitat conditions, potential development projects and other threats to ensure protection of nesting habitats.

Rationale: The nesting area for the SJBP occurs in an approximately 89,300 square-kilometer area in the southern James Bay region, including the James Bay lowlands, coastal areas and Akimiski Island (Fig. 2). The Akimiski Island coast hosts some of the highest nesting densities of subarctic Canada geese (Leafloor *et al.* 2000). Tidal flats and freshwater estuaries are the key brood rearing areas. Once thought to be relatively safe from development and major human impact, the southern James Bay area is now facing major changes. Potential hydroelectric development and community electrification on the mainland, mining and mining exploration, impoundment of James Bay, incursions into the Akimiski Island Migratory Bird Sanctuary and expanding aboriginal populations and increasing intensity of land use and impacts from expanding snow goose populations could all have a major impact on the nesting grounds of the SJBP.

Task III. A. 1. Conduct habitat inventory to classify important nesting areas and identify areas of concern.

Rationale: Classification and inventory of habitats on Akimiski Island and mainland southwestern James Bay by remote sensing techniques was conducted to gain a better understanding of the preferred habitats of nesting SJBP geese (Hudson Bay Project, unpublished). Proposed development plans in SJBP nesting range should be monitored and potential impacts identified and evaluated at the planning review stage. Collaboration with all interested parties should be sought through the Arctic Goose Joint Venture.

Task III. A. 2. Encourage Nunavut Territory, Ontario aboriginal groups, the Canadian Wildlife Service and the Ontario Ministry of Natural Resources to ensure the protection of SJBP breeding grounds from disturbance.

Rationale: To protect the great diversity of nesting and staging birds that use Akimiski Island, the eastern two-thirds of the island is designated as a Federal Migratory Bird Sanctuary. The integrity of this sanctuary should be maintained by all parties to provide a minimum disturbance breeding area for the SJBP. Because Akimiski and all other James Bay islands are now in Nunavut Territory, the Nunavut government and its wildlife authorities should be encouraged to become involved in future SJBP management discussions.

Task III. A. 3. Monitor brood habitats on Akimiski Island and southwestern James Bay mainland.

Rationale: Recent research links gosling condition and subsequent survival with quality of habitats during brood rearing, which in turn indicates population growth limitation through low recruitment. Significant portions of the Akimiski Island north shore brood rearing areas are in a degraded state. The importance of this is that Akimiski Island holds a disproportionate (relative to its size) percentage of SJBP. In addition to high densities of nesting SJBP geese, it currently supports 2500 nesting snow geese, staging

snow geese, thousands of molt migrant giant Canada geese, and thousands of migrating Atlantic brant. Foraging activities of all of these birds is expected to have a depressing effect on standing crop of edible vegetation available to SJBP geese during the brood rearing period. If populations remain too high, they will continue to negatively affect the quantity and quality of the brood rearing area vegetation. Although there is no indication of habitat problems on the southwest James Bay mainland, only limited research has been conducted there. Monitoring of brood rearing habitats throughout the range is needed to assess the effectiveness of management actions and to avail managers of the best information for decision making.

Strategy III. B. Conduct habitat inventories every 5 years of all significant SJBP migration and wintering areas and examine the efficacy of increasing components to aid in achieving the population objective.

Rationale**:** Migration and wintering areas provide essential food, water and sanctuary for geese. The amount and condition of wintering areas is important for survival and population growth. Accumulated and stored reserves obtained on fall migration areas enables continued migration and survival through inclement weather. Reserves accumulated during spring migration enables breeding birds to meet energy requirements associated with nesting and affects annual productivity. Important SJBP migration and wintering areas have been documented by Kasul and Wright (1984). Migration chronology through these areas has been partially analyzed by Smith *et al*. (1992). Numbers of geese have been declining over the last 20 years at some of these traditional SJBP wintering refuges (Orr *et al*. 1998). Similar patterns have been seen in the EPP, MVP and AP. Among the several hypotheses put forth to explain these distribution changes, creation of new refuges and wildlife management areas in the north and changes in farming practices in both north and south suggest a link between habitat changes and changing migration and winter patterns.

Task III. B. 1. Evaluate habitat management practices at key SJBP areas, to determine if resources are sufficient to provide adequate food, water and sanctuary.

Rationale: Migration and wintering areas provide food, water and sanctuary necessary to sustain the population from fall (September) until spring (early March). Dispersal of geese from management areas and effectiveness of refuges during the hunting season are closely related to availability of food. State and federal management areas should be oriented toward producing a substantial portion of the food requirements for wintering populations. A recent inventory of food, water and sanctuary was initiated for key SJBP areas (Tables 6, 7). This information should be evaluated to determine if these areas are adequate to sustain the SJBP or if, in southern areas, they could support the larger January populations stated in the distribution objective. Even though populations have been decreasing on southern wintering areas, it is important that state and federal management areas maintain or increase habitat and food resources to ensure that adequate resources are available in those years when large numbers are found to migrate to and winter on southern management areas in response to poor weather in northern areas, such as occurred in the winter of 2000-2001.

RESPONSIBILITIES FOR AND FUNDING OF RESEARCH, SURVEY AND BANDING PROJECTS DEVELOPED AS A RESULT OF THIS PLAN SHOULD BE SHARED AMONG STATES AND PROVINCES BENEFITTING FROM THE SJBP, AND FROM THE CANADIAN WILDLIFE SERVICE AND U.S. FISH AND WILDLIFE SERVICE IN ACCORDANCE WITH THEIR RESPONSIBILITIES UNDER THE MIGRATORY BIRD TREATY.

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Appendix A: Tables

Table 1: Spring population estimates for SJBP Canada Geese, 1990-2003.

	Akimiski Island		Mainland		Spring population [a]
Year	Breeding Pairs	Nonbreeders	Breeding Pairs	Nonbreeders	
1990	16,362	15,365	17,013	253	82,368
1991	10,543	11,147	27,749	20,336	108,069
1992	10,226	5,365	26,657	12,491	91,622
1993	7,045	6,576	19,436	17,808	77,346
1994	8,012	24,326	14,557	26,253	95,718
1995	7,981	9,097	28,990	10,917	93,957
1996	9,884	16,936	25,351	35,581	122,987
1997	11,186	6,500	31,472	3,286	95,102
1998	8,950	13,390	28,990	27,790	117,060
1999	11,438	8,480	42,594	20,080	136,623
2000	8,509	6,131	30,477	4,962	89,065
2001	9,232	8,513	24,919	25,857	102,671
2002	8,058	4,963	20,998	13,216	76,291
2003	7,687	1,949	37,433	14,322	106,511
1990-03	**9,651**	**9,910**	**26,903**	**16,654**	**99,671**

a Spring population size = {2 × (number of breeding pairs)} + (nonbreeders)

Table 2: Comparisons of SJBP percent recoveries for 1955-79, 1980-86, 1987-89 and 1990-97.

Area	Percent Recoveries			
	55-79	80-86	87-89	90-97 [a]
Ontario	25.6	28.5	26.2	25.8
Michigan	19.5	28.8	27.3	27.7
Ohio	10.8	12.3	15.5	25.5
Indiana	2.8	3.3	3.5	2.85
Kentucky	3.4	3.2	3.9	2.85
Tennessee	3.7	3.8	3.8	2.96
Alabama	7.9	3.0	1.8	0.5
Illinois	2.3	0.9	1.0	1.4
AF	22.6	15.4	16.7	9.7
Others	1.4	0.8	0.3	0.8
Total	100.0	100.0	100.0	100.0

a Canada goose hunting seasons closed or severely restricted in Atlantic Flyway

Table 3: Southern James Bay Population Harvest Estimates, 1990-2002.

Year	ONT	MI	IN	OH	KY	TN	AL	IL	WI	Other States*	MF Total	ATL Total	Total
1990	17,853	4,290	235	2,163	357	752	18	177	125	32	26,002	3,395	29,397
1991	15,324	4,422	278	3,744	524	701	319	183	122	38	25,654	3,349	29,004
1992	14,522	5,400	344	4,566	279	390	212	155	64	39	25,971	3,391	29,362
1993	14,776	6,348	496	5,335	1,023	746	655	203	75	28	29,684	3,875	33,559
1994	15,333	9,036	496	4,888	474	557	248	159	77	55	31,322	4,089	35,412
1995	6,610	4,004	236	3,113	773	858	328	222	0	0	16,143	946	17,089
1996	6,583	3,785	172	4,076	706	910	959	217	0	0	17,408	1,020	18,428
1997	6,726	4,963	261	4,741	577	829	433	176	0	0	18,706	1,096	19,802
1998	14,286	5,151	473	12,590	2,777	765	879	82	0	22	37,026	2,283	39,309
1999	10,026	3,742	3,609	8,457	1,105	254	104	102	0	211	27,611	1,320	28,931
2000	12,470	4,554	4,921	11,474	1,595	453	83	125	0	910	36,585	1,749	38,335
2001	14,797	5,278	5,484	8,251	885	314	68	71	0	1,100	36,249	1,733	37,982
2002	15,969	3,699	5,596	11,852	975	1,039	250	68	0	1,060	40,507	1,937	42,444

* Other States: AR, IA, LA, MN, MO, MS, MAN

State and provincial harvest calculated by using percent harvest derivations developed by WI Coop Unit (2001)

1990-94 derivations used to calculate harvest for 1990-1994 seasons.

1995-97 derivations used to calculate harvest for 1995-1997 seasons.

1998-00 derivations used to calculate harvest for 1998 season (Moser 2002)

1999-01 derivations used to calculate harvest for 2000-2002 seasons (Moser 2003)

ATL Flyway harvest calculated by derivation period by the following formula: Total MS SJBP Harvest/%MS Flyway SJBP Band Recoveries = X/%ATL Flyway SJBP Band Recoveries

Table 3a: Percent Southern James Bay Population Harvest by State or Province, 1990-2002.

Year	ONT	MI	IN	OH	KY	TN	AL	IL	WI	Other States*	MF Total	ATL Total	Total
1990	60.73	14.59	0.80	7.36	1.21	2.56	0.06	0.60	0.43	0.11	88.45	11.55	100.00
1991	52.83	15.25	0.96	12.91	1.81	2.42	1.10	0.63	0.42	0.13	88.45	11.55	100.00
1992	49.46	18.39	1.17	15.55	0.95	1.33	0.72	0.53	0.22	0.13	88.45	11.55	100.00
1993	44.03	18.92	1.48	15.90	3.05	2.22	1.95	0.60	0.22	0.08	88.45	11.55	100.00
1994	43.30	25.52	1.40	13.80	1.34	1.57	0.70	0.45	0.22	0.15	88.45	11.55	100.00
1995	38.68	23.43	1.38	18.22	4.52	5.02	1.92	1.30	0.00	0.00	94.46	5.54	100.00
1996	35.72	20.54	0.93	22.12	3.83	4.94	5.21	1.18	0.00	0.00	94.46	5.54	100.00
1997	33.97	25.06	1.32	23.94	2.92	4.19	2.19	0.89	0.00	0.00	94.46	5.54	100.00
1998	36.34	13.10	1.20	32.03	7.06	1.95	2.24	0.21	0.00	0.06	94.19	5.81	100.00
1999	34.65	12.94	12.47	29.23	3.82	0.88	0.36	0.35	0.00	0.73	95.44	4.56	100.00
2000	32.53	11.88	12.84	29.93	4.16	1.18	0.22	0.33	0.00	2.37	95.44	4.56	100.00
2001	38.96	13.90	14.44	21.72	2.33	0.83	0.18	0.19	0.00	2.90	95.44	4.56	100.00
2002	37.62	8.71	13.18	27.92	2.30	2.45	0.59	0.16	0.00	2.50	95.44	4.56	100.00

Table 4: December estimates of SJBP Canada geese in the Mississippi and Atlantic Flyways, 1969-1997.

Year	ONT	MI	IN	OH	North	KY	TN	AL	South	MF Total	AF Total	NA Total
1969	NS3	8,500	5,800	11,600	25900	5,000	44,000	32,000	81000	106900	14,300	[132,800]
1970	21,800	10,600	3,600	13,500	49500	3,500	46,500	27,800	77800	127300	17,800	176,800
1971	30,700	5,900	4,500	14,700	55800	3,500	25,800	32,500	61800	117600	10,200	173,400
1972	23,800	10,100	3,000	9,700	46600	6,000	30,700	18,500	55200	101800	9,800	148,400
1973	32,400	16,500	1,900	22,200	73000	2,800	37,400	22,800	63000	136000	8,900	209,000
1974	8,500	6,900	3,600	5,200	24200	3,100	46,000	22,700	71800	96000	15,100	120,200
1975	18,400	21,000	4,100	5,700	49200	2,300	36,500	27,500	66300	115500	16,900	164,700
1976	12,100	5,200	5,300	16,500	39100	11,400	54,300	25,000	90700	129800	15,300	168,900
1977	17,500	16,800	12,900	18,400	65600	10,200	73,000	31,600	114800	180400	15,100	246,000
1978	11,200	12,300	14,500	11,100	49100	6,000	61,000	26,600	93600	142700	8,200	191,800
1979	25,900	19,600	5,600	5,800	56900	3,000	43,000	24,100	70100	127000	7,100	183,900
1980	13,400	18,100	8,200	4,700	44400	7,700	41,900	26,300	75900	120300	8,600	164,700
1981	11,600	22,200	6,500	14,300	54600	8,100	35,800	20,000	63900	118500	11,800	173,100
1982	25,800	25,100	3,000	20,000	73900	6,500	29,100	20,400	56000	129900	9,400	203,800
1983	15,800	15,300	3,000	9,600	43700	11,900	50,800	23,500	86200	129900	6,300	173,600
1984	16,300	31,400	1,500	24,500	73700	7,500	25,400	22,700	55600	129300	7,800	203,000
1985	16,500	33,000	2,700	23,500	75700	22,100	33,300	26,900	82300	158000	3,400	233,700
1986	19,800	27,000	800	28,100	75700	13,300	25,400	15,400	54100	129800	2,900	205,500
1987	22,400	44,800	1,700	33,000	101900	18,700	22,800	15,400	56900	158800	2,600	260,700
1988	28,200	34,700	3,100	29,200	95200	15,100	30,700	29,200	75000	170200	2,800	265,400
1989	16,771	37,780	900	19,229	74680	12,800	51,700	20,200	84700	159380	5,300	234,060
1990	18,804	47,586	900	18,477	85767	23,627	25,109	7,650	56386	142153	2,000	227,920
1991	14,170	38,007	1,508	18,751	72436	9,806	21,753	3,200	34759	107195	1,000	179,631
1992	11,377	37,058	2,550	25,598	76583	9,392	15,515	2,902	27809	104392	8,606	180,975
1993	9,275	44,701	1,456	20,255	75687	9,371	8,194	2,200	19765	95452	9,582	171,139
1994	9,600	36,575	450	25,682	72307	6,455	12,040	8,430	26925	99232	NS	[171,539]
1995	NS	41,532	1,162	26,593	69287	13,236	7,196	3,450	23882	93169	NS	[162,456]
1996	6,500	41,504	118	21,678	69800	4,957	7,249	2,645	14851	84651	NS	[154,451]
1997	NS	44,800	200	NS	45000	3,600	5,100	3,700	12400	57400	NS	[102,400]
Average												
1969-75	22,600	11,400	3,700	11,800	49,500	3,800	38,100	26,900	68,800	118,800	13,300	[132,100]
1976-80	16,020	14,400	9,300	11,300	51,020	7,660	54,640	26,720	89,020	140,040	10,860	150,900
1981-85	17,200	25,400	3,340	18,380	64,320	11,220	34,880	22,700	68,800	133,120	7,740	140,860
1986-90	21,195	38,373	1,480	25,601	86,649	16,705	31,142	17,570	65,417	152,067	3,120	155,187
1991-95	11,106	39,575	1,425	23,376	73,260	9,652	12,940	4,036	26,628	99,888	6,3964	[173,148]
1996-97	6,500	43,152	159	21,678	57,400	4,279	6,175	3,173	13,626	71,026	NA5	[128,426]

1. MF survey conducted in mid December
2. AF survey conducted in January and did not include Pennsylvania
3. No survey conducted
4. Average of 1991-1994
5. Not applicable
6. Confidence in these counts is limited due to increasing presence of giant Canada geese

Table 5: Distributions and trends in numbers of SJBP Canada geese observed during the mid-winter (January) waterfowl survey in the Mississippi Flyway, 1982-1998.

Year	ONT	MI	IN	OH	KY	TN	AL	MF Total 1
1982	I/C2	12,700	9,700	15,900	15,500	50,100	20,000	[123,900]
1983	I/C	20,700	4,200	19,200	10,500	64,700	28,800	[148,100]
1984	I/C	10,600	4,500	20,700	16,200	86,900	33,600	[172,500]
1985	5,000	15,000	2,800	26,500	18,100	51,400	25,800	144,600
1986	3,000	12,900	6,900	25,600	18,600	110,000	37,500	214,500
1987	10,000	20,100	6,300	29,800	8,800	84,700	31,800	191,500
1988	22,400	25,500	3,900	24,400	30,600	64,600	30,300	201,700
1989	21,200	28,500	6,600	21,300	24,300	105,400	24,200	231,500
1990	12,605	13,124	5,400	15,992	24,986	112,830	47,000	231,937
1991	11,382	24,107	150	24,001	31,476	29,076	9,000	129,192
1992	12,868	43,981	645	16,805	17,566	58,708	7,315	157,888
1993	11,239	26,379	972	16,774	8,107	22,306	2,880	88,657
1994	9,600	36,575	450	25,682	6,455	12,040	8,430	99,232
1995	No Survey	41,532	1,162	26,593	13,236	7,196	3,450	[93,169]
1996	15,035	31,595	736	26,345	13,062	36,613	22,204	145,590
1997	13,293	22,170	1,205	39,574	5,729	11,833	2,400	96,204
1998	15,076	34,345	198	21,905	4,294	11,532	2,639	89,989
Average								
1982-85	n/a	14,750	5,300	20,575	15,075	63,275	27,050	[147,275]
1986-90	13,841	20,025	5,820	23,418	21,457	95,506	34,160	214,227
1991-95	n/a	34,515	676	21,971	15,368	25,865	6,215	[94,994]
1996-98	14,468	29,370	713	29,275	7,695	19,993	9,081	110,594

1. Includes Mississippi Flyway States that have an SJBP count
2. Incomplete survey
3. Confidence in these counts is limited due to increasing presence of giant Canada geese.

Table 6: Characteristics of key SJBP Migration and Wintering Concentration Areas (1999).

Area	Crop Acres	Browse Acres	Moist Soil	Open Water	Refuge Acres	Average Peak #	Goose-Use Days	Total Acres
OHIO								
Ottawa NWR	440	284	4,026	1,615	7,716	3,000	390,000	8,316
Magee WA	0	50	1,500	0	268	200	26,000	1,821
Gressmans	0	44	0	1	45	300	39,000	45
Mosquito	940	465	600	1,100	7,575	8,000	1,040,000	8,525
Muddy Creek Bay	0	0	280	2,400	2,400	4,000	520,000	2,700
Cleveland Metro Parks	0	200	0	100	300	1,000	130,000	300
Sandusky Park	0	30	0	10	40	1,000	130,000	40
Killdeer Plains WA	141	250	30	320	3,750	2,000	260,000	8,000
Total	1,521	1,323	6,436	5,546	22,094	19,500	2,535,000	29,747
INDIANA								
Mascatatuck	300	2,000	0	1,500	8,000	5,000		
Jasper-Pulaski	220	100	0	120	440	2,000	49,893	880
Hovey Lake	1,445	50	0	500	400	225	14,210	1,800
Pigeon River	300	100	100	210	710	2,500	99,174	1,000
Tri-C	100	75	403	228	168	180	7,781	630
Total	2,365	2,325	503	2,558	9,718	9,905	171,058	4,310
PENNSYLVANIA								
Pymatuning	1,418	709	1,265	3,800	4,000	2,243	82,812	9,543
Erie NWR	700	700	2,500	2,500	8,750	504	1,016	8,750
Total	2,118	1,409	3,765	6,300	12,750	2,747	83,828	18,293
MICHIGAN								
Lapeer Game Area	953	11	0	896	820			8,400
Muskegon WW	5,500	400	200	1,700	1,700			11,000
Fish Point	1,124	140	50	500	680			2,200
Shiawassee NWR	1,440	145	386	2,273	7,051			8,984
Shiawassee SGA	1,600	99	160	1,584	850			8,490
Crow Isle. SGA	520	64	0	840	230			3,065
Nayanquing Pt. WA	310	18	25	425	411			1,396
Leidy Lake	367	26	22	72	487			487
Allegan SGA	1,400	800	0	30	1,380			4,000
Kellogg Sanctuary	250	325	0	80	2,000			2,000
Total	13,464	2,028	843	8,400	15,609			50,022

Table 6 – Continued

KENTUCKY								
Sloughs	2,700	500	400	200	2,265	4,500	3,000,000	10,500
Coal Fields	1,000	500	0	300	1,200	2,000	300,000	2,200
Barkley LK	100	190	100	3,000	1,600	6,000	360,000	650
Total	3,800	1,190	500	3,500	5,065	12,500	3,660,000	13,350
TENNESSEE								
Tennessee NWR	3,000	250	1,200	25,179	51,538	18,000	1,620,000	51,858
Cross Ck NWR	1,300	500	700	1,400	8,862	19,000	691,000	8,862
KY/Barkley Lakes.	611	185	580	6,800	0	2,000		22,616
Chickamauga/								
Watts Bar WMA	1,765	468	260	390	7,889	2,820	1,853,250	18,054
Total	6,676	1,403	2,740	33,769	68,289	41,820	4,164,250	101,390
ALABAMA								
Wheeler NWR	3,500	650	2,000	15,000	34,000	2,900	4,000,000	34,000
NORTH CAROLINA								
Pee Dee NWR	840	230	30	48	8,400	170	5,700	8,400
SOUTH CAROLINA								
Santee NWR	174	240	250	9,000	15,095	650	45,900	
Carolina Sandhills	8	39	43	198	45,348	70	3,700	45,348
Grand Total	34,466	10,837	17,170	84,371	191,090	90,262	14,669,436	319,955

Table 7: Major landscape cover types for primary states and provinces used by Southern James Bay Canada geese. Only those areas within the SJBP range boundaries were included. [a]

	Landscape cover types (acres)															
	Agricultural cropland most used by geese (grain, browse, beans)													Water		
	Cereal grains and browse							Beans								Estimated acreage available to SJBP geese (grain, browse, and water)
State / province [b]	Corn	Wheat	Oats	Rye	Barley	Sorghum	Hay/pasture	Soybeans	Other beans	Fruits, nuts & vegetables	Cotton	Tobacco	Forestland	Inland	Great Lakes coastal [c]	
Mississippi Flyway																
Alabama	300,000	120,000	35,000				4,276,600	340,000		219,000	495,000		21,737,700	1,241,700		6,313,300
Illinois	10,600,000	1,250,000	85,000	50,000		108,000	3,475,100	10,600,000		43,700			3,924,000	761,200	18,200	26,947,500
Indiana	5,800,000	700,000	50,000	15,000			2,567,600	5,700,000		32,000		8,500	3,833,900	386,100	14,400	15,233,100
Kentucky	1,320,000	650,000			9,000	10,000	7,962,600	1,200,000				226,300	11,044,600	628,800		11,780,400
Michigan [d]	2,300,000	600,000	120,000	65,000	30,000		3,253,500	1,900,000	300,000	433,400			10,468,900	835,200	288,300	9,692,000
Ohio	3,730,000	1,200,000	120,000	35,000			3,309,600	4,400,000		50,400		9,800	7,212,100	408,100	64,000	13,266,700
Tennessee	700,000	570,000					6,770,200	1,250,000		15,900	450,000	59,400	12,370,900	787,200		10,077,400
Atlantic Flyway																
New York	1,130,000	140,000	115,000	50,000	18,000		4,026,900	100,000	31,000	258,100			17,549,000	1,286,000	98,200	6,995,100
North Carolina	860,000	730,000	40,000	90,000	25,000	12,000	2,649,800	1,415,000		259,500	710,000	251,100	16,921,500	2,776,900		8,598,700
Pennsylvania	1,550,000	195,000	190,000		80,000		3,661,600	400,000		81,700		7,800	15,819,500	480,000	14,100	6,570,700
South Carolina	350,000	265,000	40,000	30,000	4,000	6,000	1,502,400	540,000		12,000	290,000	45,000	11,570,700	820,800		3,558,200
Virginia	500,000	280,000		80,000	90,000		4,331,300	500,000		95,200	92,000	45,000	14,689,000	1,958,100		7,739,400
West Virginia	65,000	11,000	7,000				2,082,900			9,300		1,600	11,504,800	169,900		2,335,800
Ontario	2,150,000	710,000	110,000		325,000			2,100,000	75,000	206,400		66,900	195,000,000		469,100	5,939,100
Total	31,355,000	7,421,000	912,000	415,000	581,000	136,000	49,870,100	30,445,000	406,000	1,716,600	2,037,000	721,400	353,646,600	12,540,000	966,300	135,047,400

a 1970-1999 SJBP range boundaries determined from smith 1998 (MS Thesis, University of Wisconsin, Madison). (Acreage figures listed are for whole state and must be adjusted / corrected by state representatives.

b Cover type sources: U.S. Department of Agriculture-National Agriculture Statistics Service (USDA-NASS) 1997 Census of Agriculture, USDA-NASS 1998-1999 State Agriculture Statistics Service data, USDA-Forest Service.
1999 Land Area Report, Ontario Ministry of Agriculture-Food and Rural Affairs 1998 Statistics, Ontario Ministry of Natural Resources-Forest Overview, Michigan Dept. of Natural Resources-Forest Management Division
1993 Forest Inventory and Analysis data (Lower Peninsula only)

c Great Lakes coastal water estimated using shoreline length (miles) × 0.5 mile wide × 640 = Area (acres).

d Includes Lower Peninsula only, where SJBP geese most commonly occur.

Appendix B: Figures

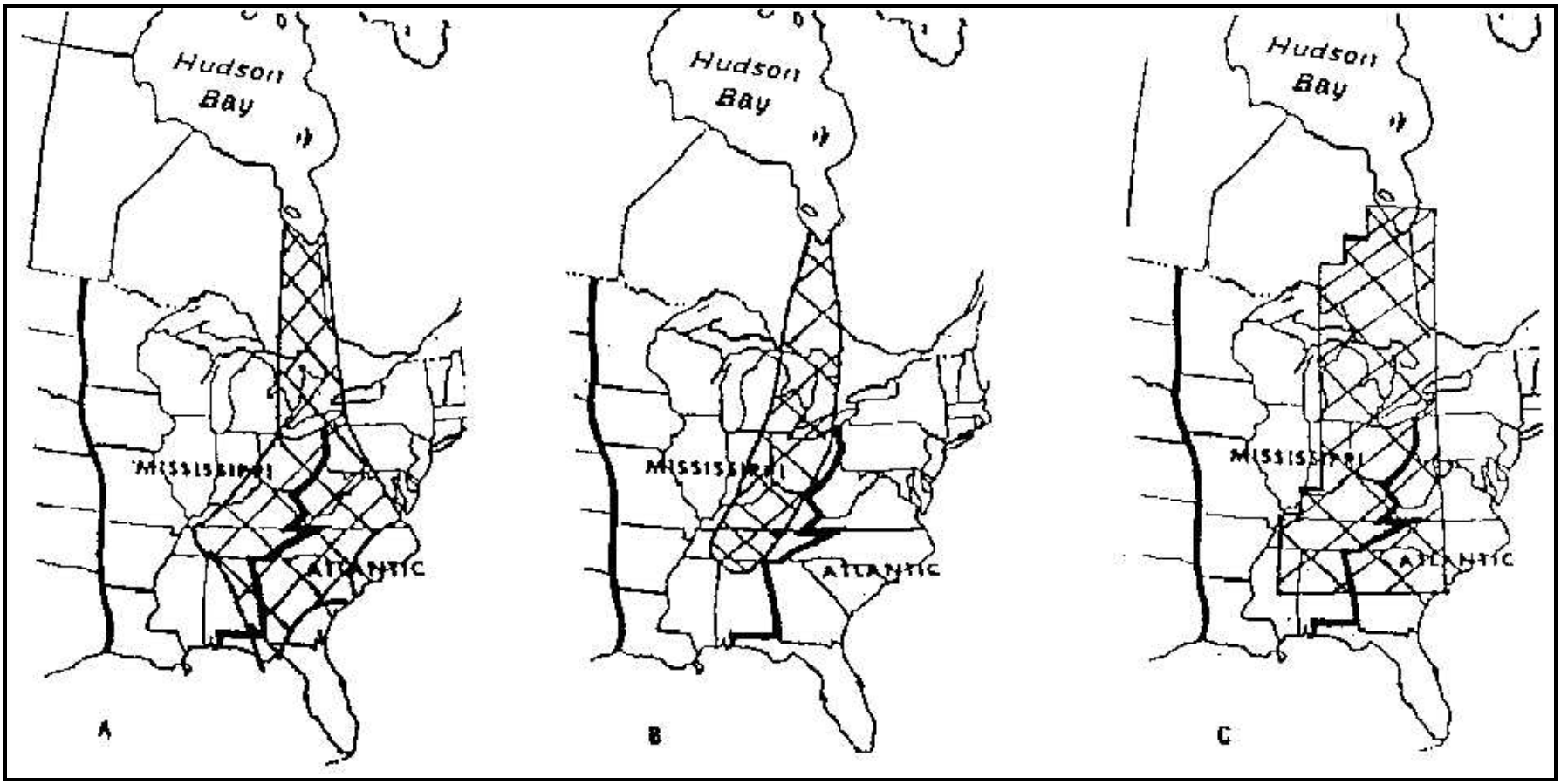


Figure 1: Range maps of Canada geese associated with Akimiski island as presented by: (A) Hanson and Smith (1950), (B) Cummings (1973) and Bellrose (1976), and (C) Bednarik and Lumsden (1977).

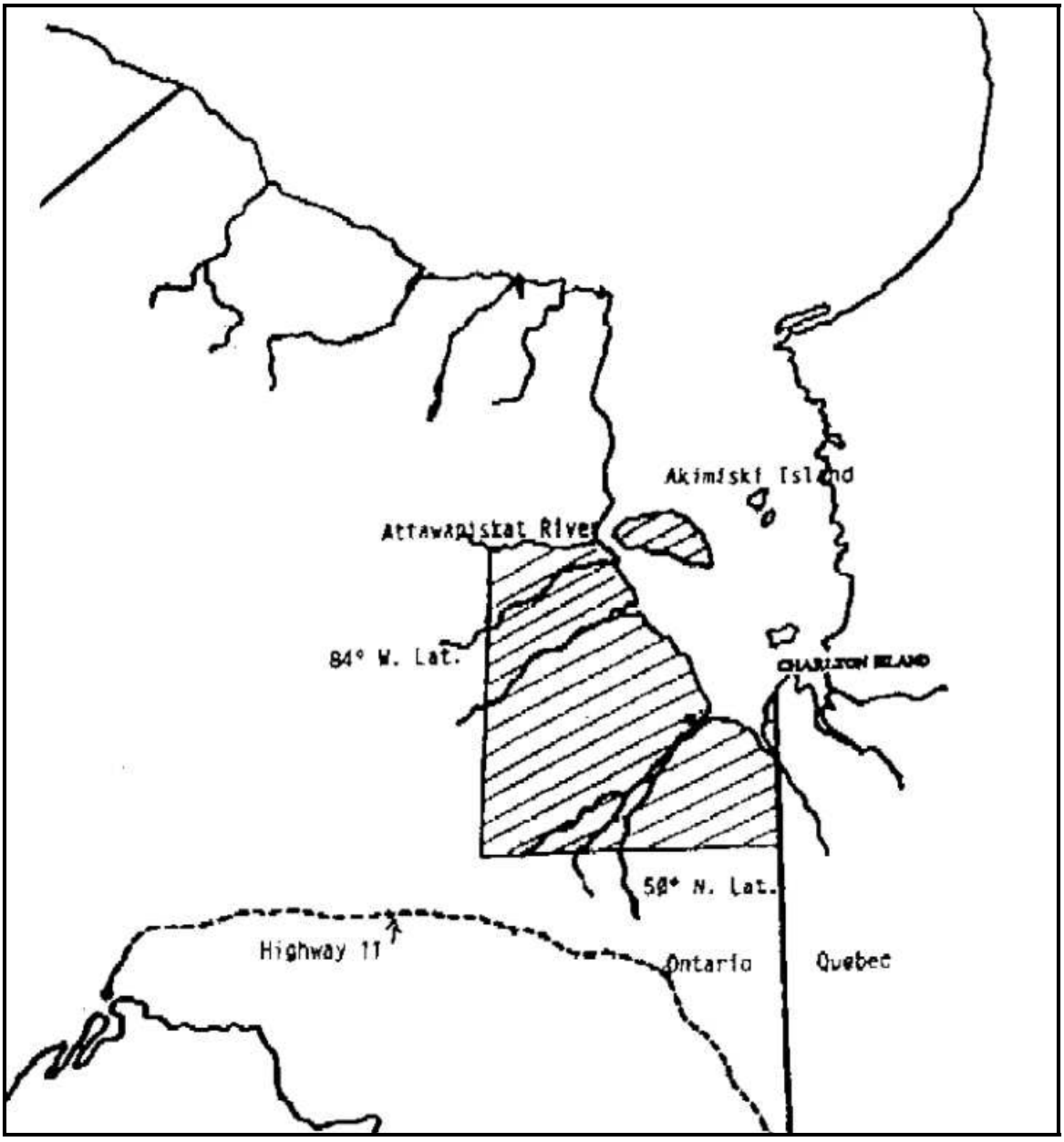


Figure 2: Current breeding range of the SJBP of Canada geese (Leafloor, 1992).

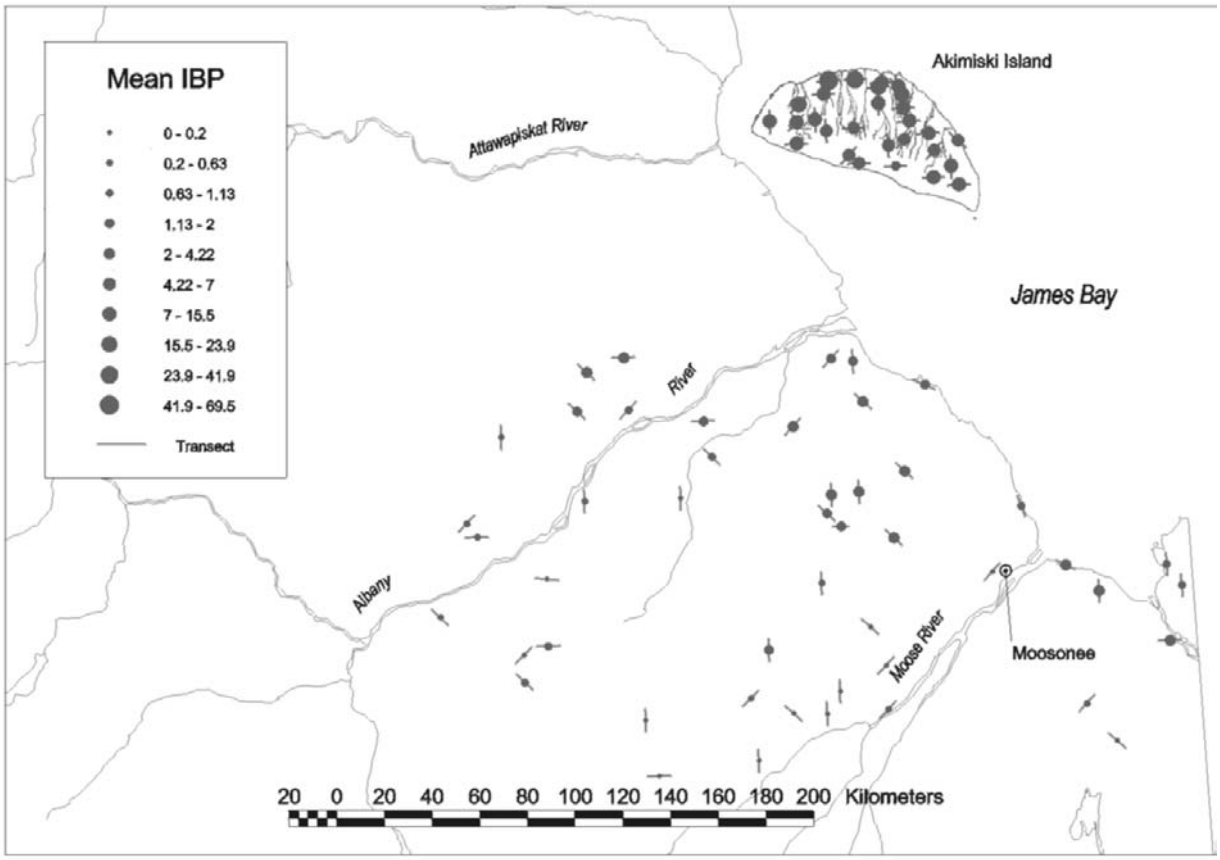


Figure 3: Southern James Bay Goose Population Survey. Mean Indicated Breeding Pair Densities from 1990 to 1999.

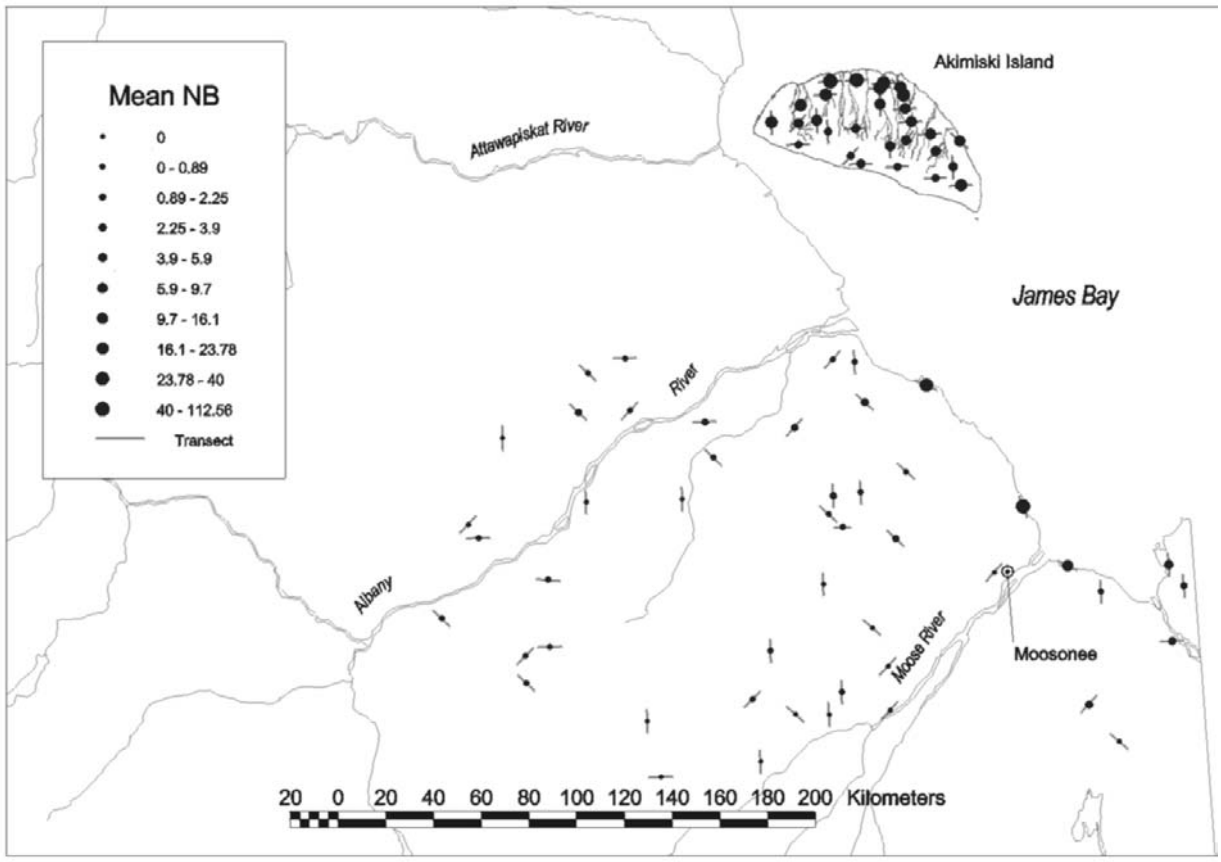


Figure 4: Southern James Bay Goose Population Survey. Mean Non-breeding Densities from 1990 to 1999.

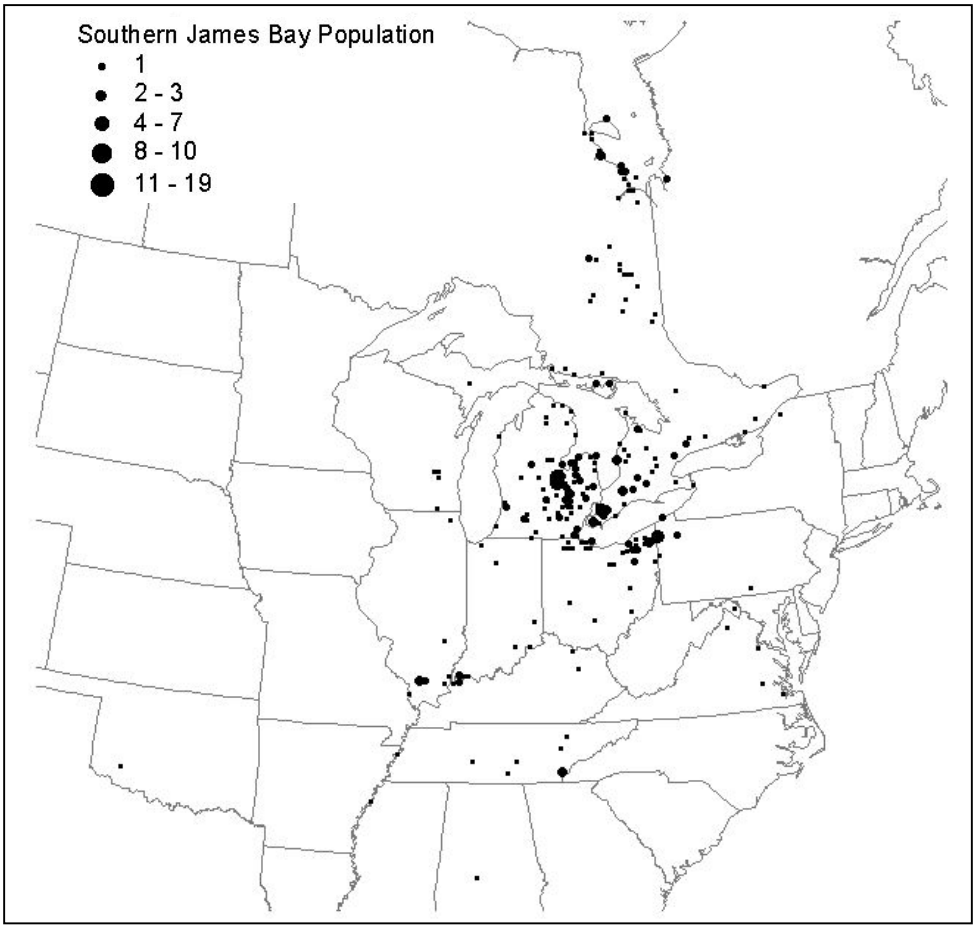


Figure 5: Recoveries of Canada Geese banded as locals from May through August on SJBP breeding grounds (≤ 83 degrees) and shot or found dead during or after 1990.

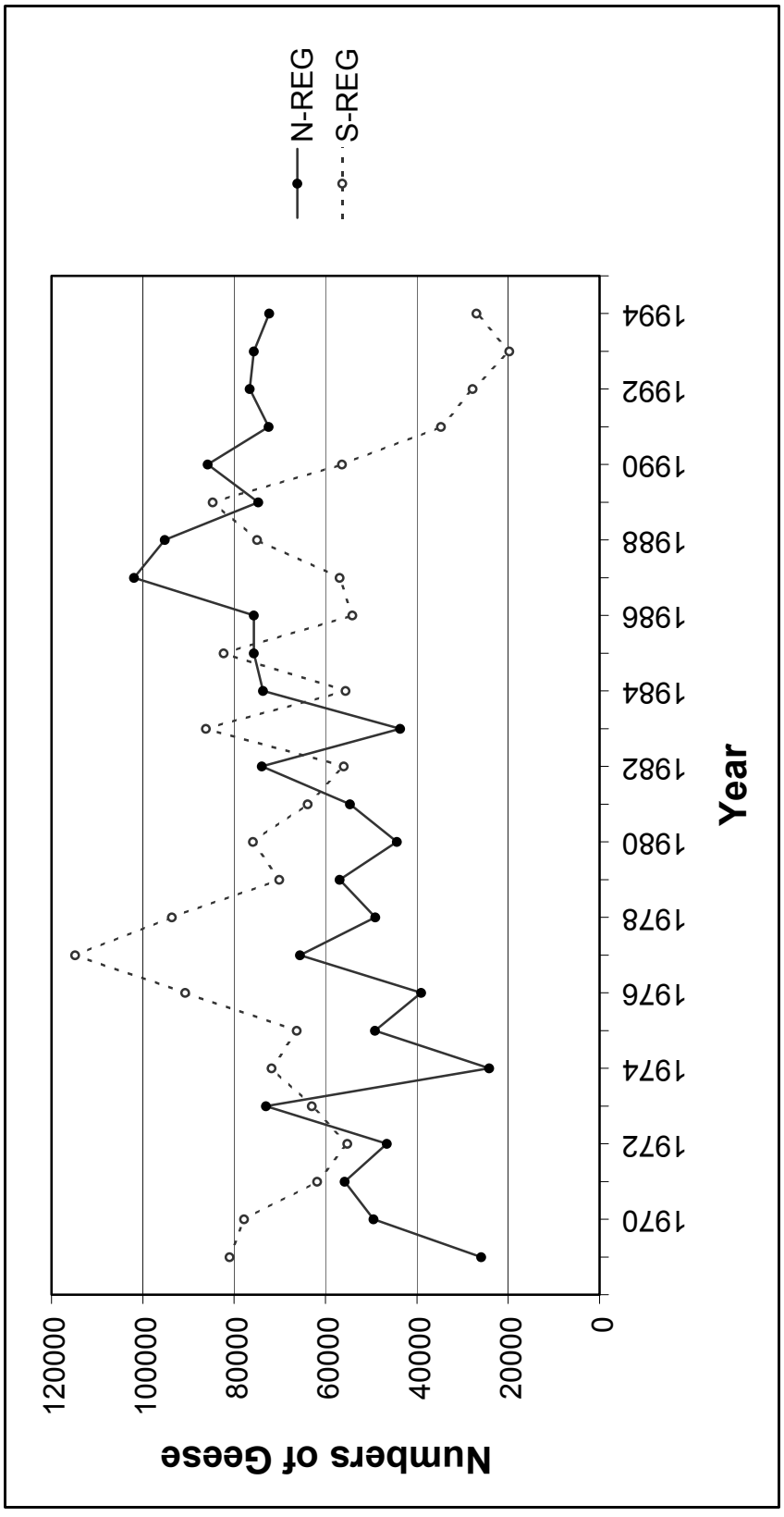
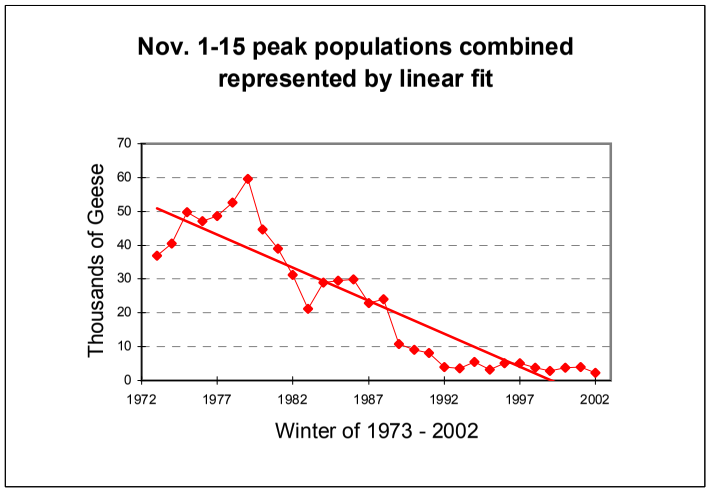
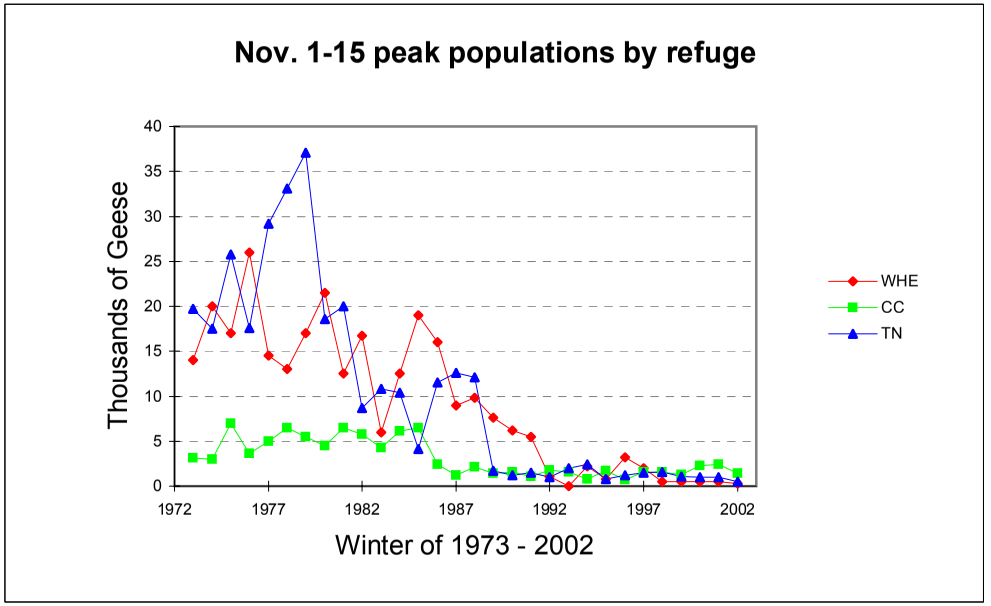


Figure 6: December estimates of SJBP Canada Geese by Regional Group.

DIFF	WHE	CC	TN	Comb.
1973	14.0	3.1	19.7	36.8
1974	20.0	3.0	17.5	40.5
1975	17.0	7.0	25.8	49.8
1976	26.0	3.6	17.6	47.2
1977	14.5	5.0	29.2	48.7
1978	13.0	6.5	33.1	52.6
1979	17.0	5.5	37.1	59.6
1980	21.5	4.5	18.6	44.6
1981	12.5	6.5	20.0	39.0
1982	16.7	5.8	8.7	31.2
1983	6.0	4.3	10.8	21.1
1984	12.5	6.1	10.4	29.0
1985	19.0	6.5	4.1	29.6
1986	16.0	2.4	11.5	29.9
1987	9.0	1.2	12.6	22.8
1988	9.8	2.1	12.1	24.0
1989	7.6	1.4	1.7	10.7
1990	6.2	1.6	1.2	9.0
1991	5.5	1.1	1.5	8.1
1992	1.1	1.8	1.0	3.9
1993	0.0	1.6	2.0	3.6
1994	2.2	0.8	2.4	5.4
1995	0.8	1.7	0.8	3.3
1996	3.2	0.7	1.2	5.1
1997	2.0	1.6	1.5	5.1
1998	0.5	1.6	1.6	3.7
1999	0.5	1.3	1.1	2.9
2000	0.5	2.3	1.0	3.8
2001	0.5	2.4	1.0	3.9
2002	0.3	1.4	0.5	2.2





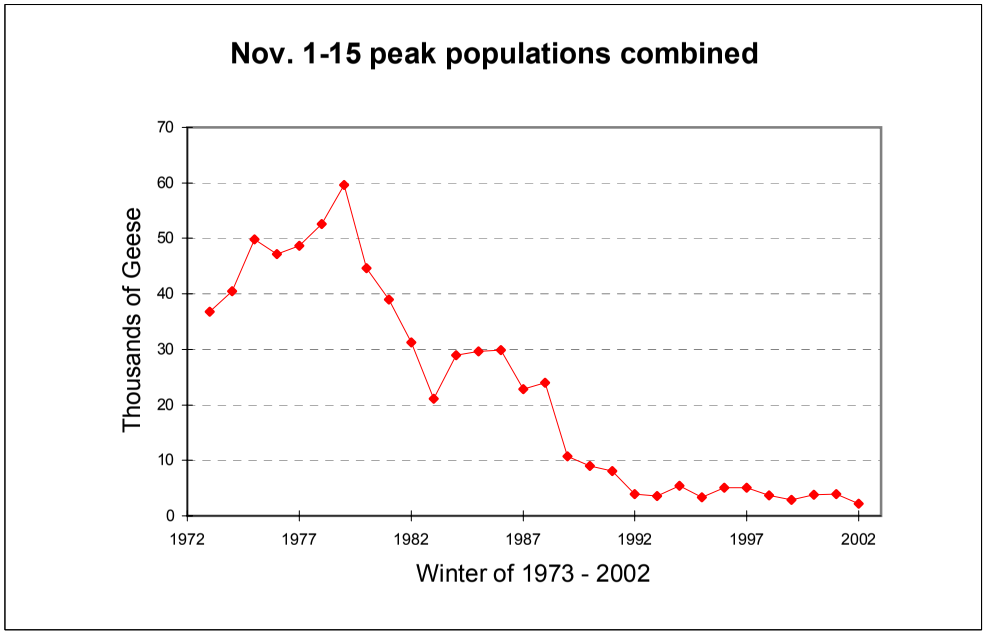
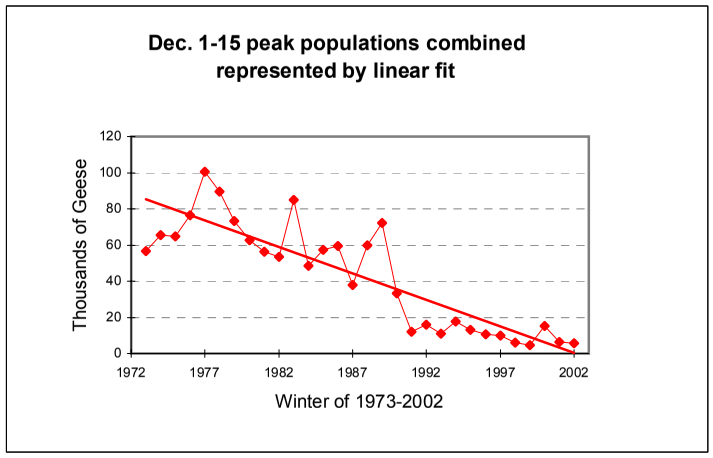
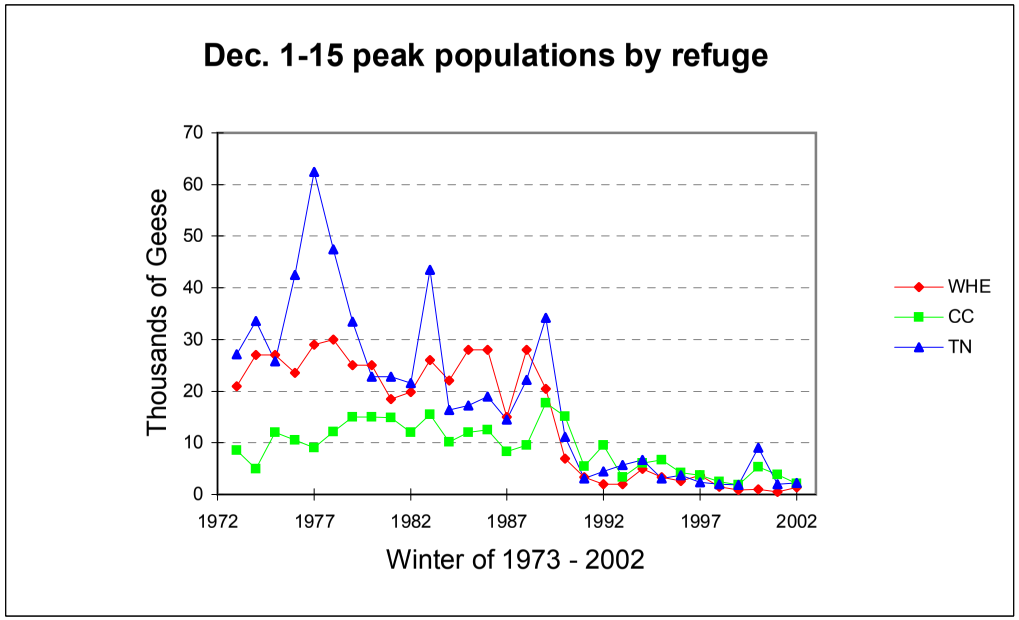


Figure 7a. November 1-15 Peak Canada Goose Populations for Wheeler, Cross Creeks and Tennessee NWR's 1973-2002. c:\wh cc tn nov-jan peaks 03/17/03

DIFF	WHE	CC	TN	Comb.
1973	21.0	8.6	27.1	56.7
1974	27.0	4.9	33.6	65.5
1975	27.0	12.0	25.8	64.8
1976	23.5	10.5	42.5	76.5
1977	29.0	9.1	62.4	100.5
1978	30.0	12.1	47.5	89.6
1979	25.0	15.0	33.4	73.4
1980	25.0	15.0	22.8	62.8
1981	18.5	14.9	22.8	56.2
1982	19.8	12.0	21.5	53.3
1983	26.0	15.5	43.5	85.0
1984	22.0	10.1	16.4	48.5
1985	28.0	12.0	17.2	57.2
1986	28.0	12.5	19.0	59.5
1987	15.0	8.3	14.5	37.8
1988	28.0	9.6	22.2	59.8
1989	20.4	17.7	34.2	72.3
1990	7.0	15.1	11.2	33.3
1991	3.4	5.4	3.1	11.9
1992	2.0	9.6	4.4	16.0
1993	2.0	3.3	5.7	11.0
1994	5.0	6.1	6.7	17.8
1995	3.3	6.7	3.1	13.1
1996	2.6	4.2	3.7	10.5
1997	3.7	3.7	2.4	9.8
1998	1.5	2.5	2.0	6.0
1999	0.9	1.9	1.9	4.7
2000	1.0	5.3	9.0	15.3
2001	0.5	3.9	2.0	6.4
2002	1.4	2.1	2.2	5.7





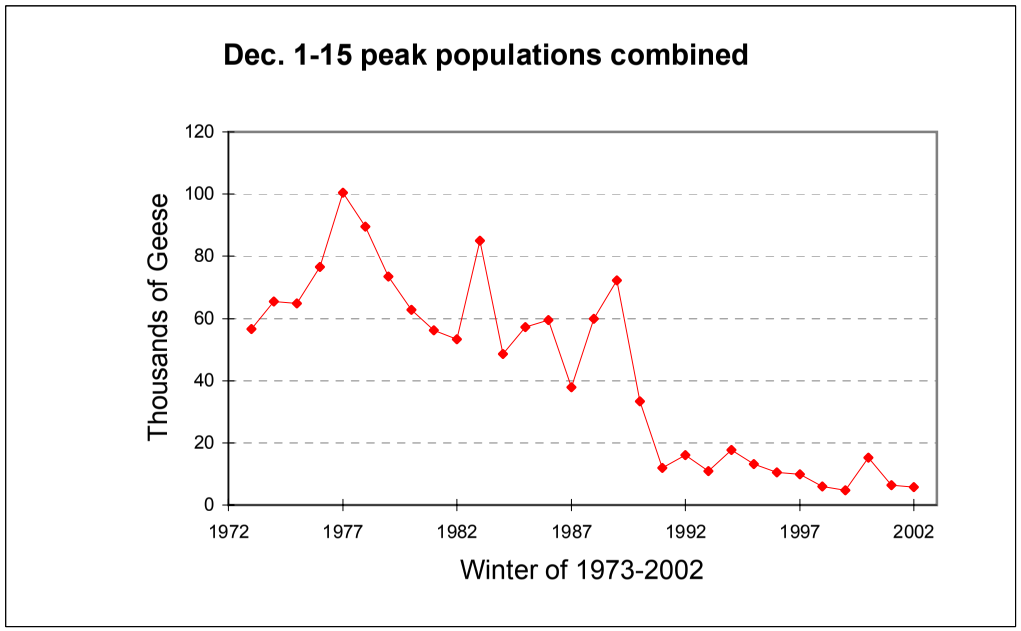


Figure 7b. December 1-15 Peak Canada Goose Populations for Wheeler, Cross Creeks and Tennessee NWR's 1973-2002.

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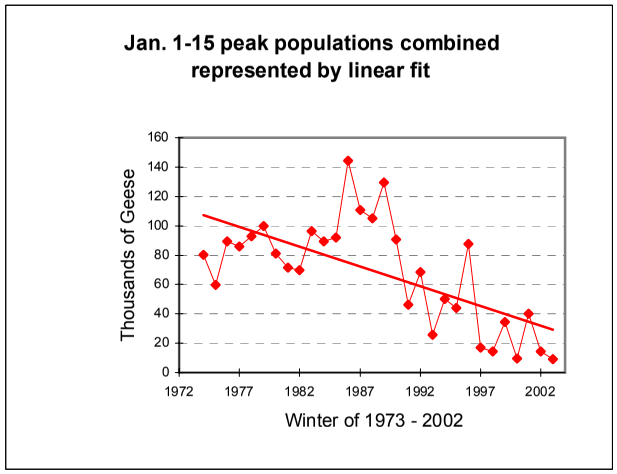
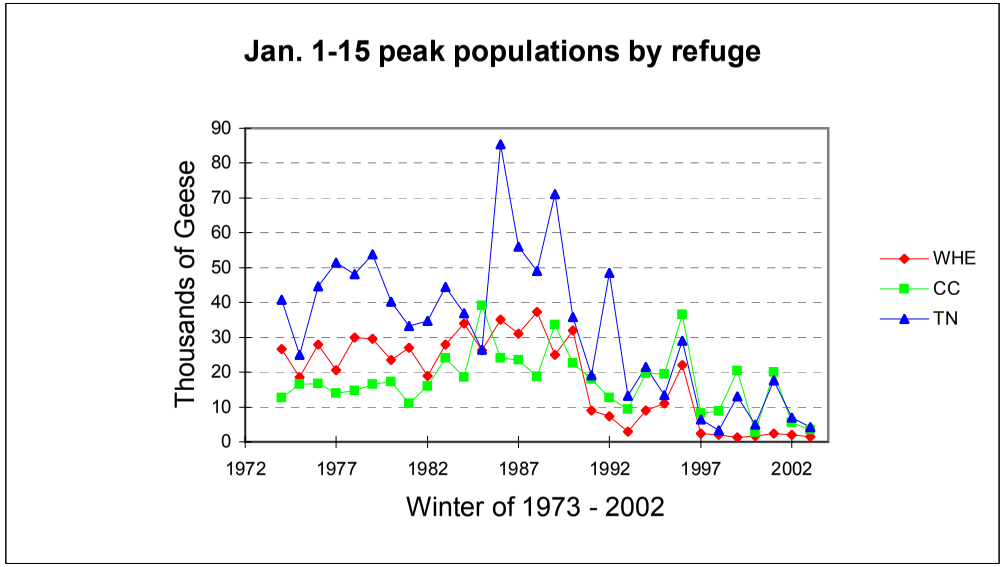
DIFF	WHE	CC	TN	Comb.
1974	26.7	12.7	40.8	80.2
1975	18.5	16.5	24.9	59.9
1976	28.0	16.8	44.7	89.5
1977	20.5	14.0	51.5	86.0
1978	30.0	14.7	48.2	92.9
1979	29.5	16.5	53.9	99.9
1980	23.5	17.2	40.2	80.9
1981	27.0	11.0	33.3	71.3
1982	19.0	16.0	34.7	69.7
1983	28.0	24.0	44.4	96.4
1984	34.0	18.5	37.0	89.5
1985	26.3	39.2	26.4	91.9
1986	35.0	24.0	85.5	144.5
1987	31.0	23.5	56.1	110.6
1988	37.3	18.8	49.0	105.1
1989	25.0	33.7	71.0	129.7
1990	32.0	22.6	35.9	90.5
1991	9.0	18.0	19.1	46.1
1992	7.3	12.6	48.4	68.3
1993	3.0	9.4	13.2	25.6
1994	9.0	19.7	21.4	50.1
1995	11.0	19.4	13.5	43.9
1996	22.0	36.6	29.1	87.7
1997	2.4	8.3	6.5	17.2
1998	2.0	8.9	3.3	14.2
1999	1.2	20.4	13.0	34.6
2000	1.7	2.7	5.0	9.4
2001	2.3	20.0	17.6	39.9
2002	2.0	5.6	7.0	14.6
2003	1.5	3.4	4.2	9.1





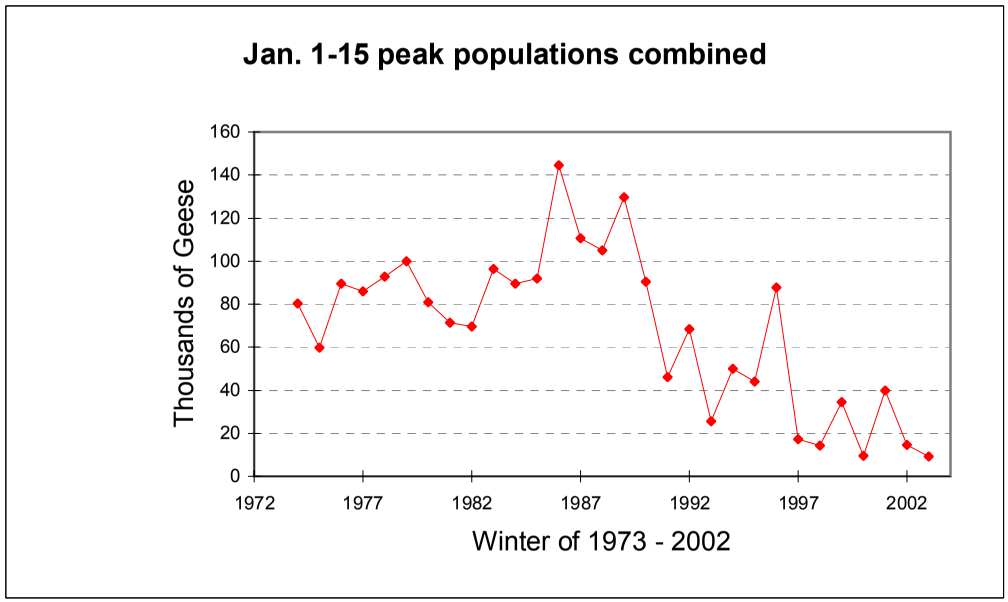


Figure 7c. January 1-15 Peak Canada Goose Populations for Wheeler, Cross Creeks and Tennessee NWR's 1973-2003.

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Appendix C: Simulated SJBP Growth and Harvest Potential (by David Luukkonen)

Because of overlap in committee memberships and interests, this task was developed in coordination with the Mississippi Valley Population (MVP) Technical Committee. Initial work focused on developing a model structure that was biologically realistic and could easily accommodate population-specific inputs.

A review of literature and discussions with biologists studying geese formed the basis for developing a model structure. Age structured fecundity and survivorship patterns in Canada geese made matrix models an attractive approach for modeling goose populations. While the initial model structure was chosen based on information available for MVP geese, the matrix structure was easily adapted to the SJBP.

The structure for the model in matrix notation is:

$$\mathbf{n}_{t+1} = \mathbf{A}\mathbf{n}_t - \mathbf{h}_t$$

Where $\mathbf{n}_t$ and $\mathbf{n}_{t+1}$ are vectors that represent the fall population of geese in six age classes in year t and t+1. The matrix **A** is six by six with elements containing age-specific reproductive and survival rates. Goose harvest is represented by $\mathbf{h}_t$. Although the notation used here differed slightly, this model was adapted for goose populations from work by Getz and Haight (1989) and Caswell (1989).

The prototype model was developed as an EXCEL® spreadsheet to facilitate access by a wide range of users, however, other programs are currently being explored that might allow greater utility and flexibility. For example, although the current form of the model is deterministic (constant reproduction and survival), elements of the projection (**A**) matrix can be entered as random variables. There is also interest in considering an alternative model structure that allows year-specific inputs ($\mathbf{A}_t$). A year-specific model would allow biologists to make use of reproductive information gathered each year (e.g. nest success and young fledged) or use predictions from established relationships (e.g. predictions of reproductive success based on weather).

SJBP Simulation and Projection Methods

The SJBP was modeled assuming birds nesting on Akimiski Island had different reproductive characteristics than birds nesting on the mainland (Table C1). Reproductive characteristics of SJBP on Akimiski Island were taken from (Leafloor *et al*. 1997, Leafloor personal communication 1999). Mainland nesters were assumed to have reproductive rates similar to MVP geese, so estimates for nest success, young fledged per successful nest, and survival of young from hatching to fledging were taken from Bruggink *et al*. (1994). Estimates for age-specific nesting rates were provided by Leafloor (unpublished data from observations of brood patch females on banding drives). I assumed no difference in age-specific nesting rates on the mainland compared to Akimiski Island (Table C1). Survival rates of geese after fledging represent rates in the absence of hunting and are based on discussion with biologists studying geese (Table C2). Hunting mortality was assumed additive to non-hunting mortality. The weighted average of mainland and Akimiski Island reproductive and survival rates was used in projecting population growth. I assumed that 72% of the SJBP nests on the mainland, which is based on the distribution of nesting geese measured during the spring aerial survey. Estimates provided in Tables C1 and C2 are preliminary and will be revised as new data and analyses become available.

Table C1: Reproductive rate inputs for mainland and Akimiski Island geese.

Parameter	Mainland [a]	Akimiski Island [b]
Nesting Rate of 2-year olds	0.40	0.40
Nesting Rate of 3-year olds	0.70	0.70
Nesting Rate of 4-year olds	0.95	0.95
Nesting Rate of 5+year olds	1.00	1.00
Nest Success	0.58	0.79
Young/Successful Nest	3.85	3.74

a Nesting rates for mainland and Akimiski Island from Leafloor (unpublished data from banding drives) and nest success and fledging rate from Bruggink *et al*. 1994).

b Nest success and young/successful nest from Leafloor *et al*. (1997).

Table C2: Survival rate inputs for mainland and Akimiski Island geese in the absence of hunting.

Parameter	Mainland	Akimiski Island
Survival (Hatch-Fledge)	0.41 [a]	0.54 [b]
Survival (Fledge to 1 yr)	0.80	0.40
Survival (1yr to 2 yr)	0.90 and 0.95	0.90 and 0.95
Survival (Adults)	0.90 and 0.95	0.90 and 0.95

a MVP survival from hatching to fledging taken from Bruggink *et al*. (1994); other mainland survival rates assumed from discussions with goose biologists.

b Survival from hatch to banding taken from Leafloor *et al*. (1997) and corrected for total brood losses assuming 8 % total brood loss(Bruggink *et al*. 1994). Estimates of survival to fledging were made assuming daily survival was constant after hatching and fledging occurred 56 days post-hatch. Survival of fledglings based on known mortality of 107 radio-tagged goslings after banding but prior to fall migration in 1999 (Leafloor unpublished data).

Because no data were available on the age-class structure of the SJBP, I began with the assumption of equal numbers in each age-class. I then grew a hypothetical population in the absence of hunting for 9 years. This length of time allowed the age distribution to stabilize in accordance with reproductive and survival rates. I initiated harvest mortality in the tenth year of projection and assumed harvest rates of first-year geese exceeded harvest rates of older geese by a constant multiple. Direct recovery rates of juvenile leg banded MVP geese were about 1.6 times the recovery rate of older geese for the period 1980-97 and this value was used for modeling SJBP. I iteratively changed harvest rates of geese > 1 year old and estimated the resulting SJBP growth rate. I repeated simulations for two levels of adult mortality (0.9 and 0.95; Table C2).

SJBP SIMULATION RESULTS

Population growth projections represent expected population responses to different sets of static conditions. Under the current estimated harvest rate of 0.21, the SJBP would be expected to grow at a modeled rate of 5.4 or 9.5% per year, depending on survival assumptions (Fig. C1). Projected growth of 5.4% per year under the low survival assumption is close to the estimated 4% growth rate derived from spring surveys (Fig. C1).

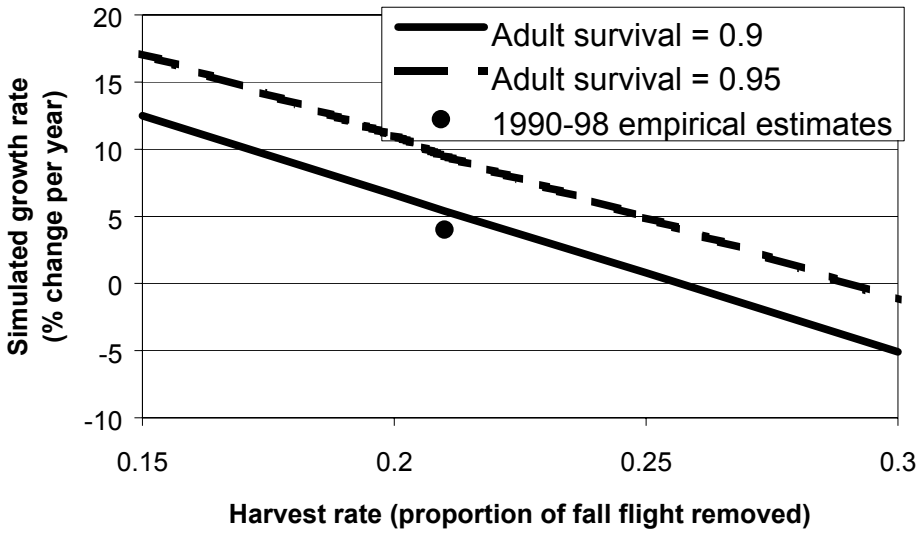

Figure C1: Projected SJBP growth under different harvest rates and survival assumptions. Also shown is the point on the graph representing the empirical estimates of SJBP harvest rate and growth for the period 1990-98.

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Abraham, K. F. and J. R. Bergquist (editors). 1998. Management plan for the Mississippi Valley Population of Canada geese, 1997-2002.

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Caswell, H. 1989. Matrix population models. Sinauer Associates, Massachusetts.

Getz, W. M. and R. G. Haight. 1989. Population Harvesting: Demographic models of fish, forest, and animal resources. Monographs in Population Biology: 27.

Leafloor, J. O., M. R. J. Hill, D. H. Rusch, K. F. Abraham, and R. K. Ross. 1997. Nesting ecology and survival of Canada geese on Akimiski Island, Northwest Territories. Unpublished manuscript.

Appendix D: Research and Information Needs Beyond 2001

The following is a list of research and information needs related to the Strategies and Tasks of the 2001. Development of any of these projects by management agencies and cooperating partners is encouraged where suitable funding opportunities exist in addition to currently supported operational SJBP programs.

1. Revise delineation of the nesting range of SJBP and MVP in northwestern James Bay.
2. Examine timing and numbers of molt migration of giants and influence of molt migrants on SJBP habitat.
3. Comprehensively examine effects of special hunting seasons designed for management of giant Canada geese, on survival and harvest rates of SJBP geese.
4. Continue to evaluate the use of genetic techniques for harvest derivation, and composition of migration and winter populations.
5. Have SJBP Canada geese included in a reward band study of recovery rates.
6. Conduct First Nations harvest survey and population specific harvest.
7. Develop information on traditional First Nations harvest practices.
8. Examine migration and winter area philopatry and differential harvest rates among these areas.
9. Evaluate temporal and spatial trends of breeding pair density to determine habitat associations.
10. Conduct an evaluation of brood habitat on the mainland nesting range, both coastal and interior.
11. Examine age structure of the breeding population, especially on Akimiski Island.
12. Determine age related breeding propensity of birds on Akimiski Island.
13. Determine age-related breeding productivity.
14. Examine the role of predators in mortality of goslings on Akimiski Island.
15. Conduct a study of total brood loss on Akimiski Island.
16. Conduct nesting biology study on the mainland range to determine reproductive parameters of this segment of the population.
17. Estimate survival rates of first year birds from Akimiski Island.
18. Examine spatial and temporal variation in fall migration..
19. Identify important migration staging areas of SJBP with satellite telemetry.
20. Determine carrying capacity of wintering areas in "deep south".
21. Consider winter banding projects using morphometric and genetic discrimination techniques to identify stocks pre and/or post banding.

SJBP Management Plan

Appendix E. Delineation of SJBP Harvest Areas in the Atlantic Flyway

Atlantic Flyway Canada geese are managed under SJBP (Southern James Bay Population), AP (Atlantic Population), NAP (North Atlantic Population) and RP (Resident Population) hunting zones and regulations. Historically SJBP harvest zones were created in portions of northwestern Pennsylvania, western New York and North and South Carolina**.** Direct recovery rates of SJBP Canada geese in the Atlantic Flyway have historically been low comprising less than 10% of the total take of banded geese (Raftovich and Smith 2002).

In 1997, the Atlantic Flyway Council proposed the creation of a regular Canada goose season in much of the western portion of the flyway that contained few band recoveries or neckband observations of AP Canada geese. The USFWS (Service) concurred with the proposal and expanded the existing SJBP zone into non-AP areas of the flyway that were not previously defined as SJBP harvest areas. Since 1997, much of the western portion of the flyway has been under SJBP regulations consistent with the SJBP Management Plan. Small numbers of SJBP geese occur throughout this large region that has not been well delineated with respect to SJBP Canada geese. The SJBP Management Plan recognizes the need for up-to-date delineation of harvest areas and SJBP concentration areas for making harvest management decisions. The Canada goose population that is most critical to a region or state/province should drive harvest regulations, however, some consideration may be given to the status of other populations commensurate with their occurrence and harvest in the goose zone.

SJBP harvest areas are defined as those areas that comprise at least 70% of the SJBP recoveries in a state or province (SJBP Management Plan Task 1.B.1). In addition areas with traditional wintering or migration value in a state were also identified as SJBP areas (e.g. NC, SC). A total of 1,636 SJBP recoveries were recorded during the 1950-2001 hunting seasons in the Atlantic Flyway (Table 1). Of these 962 (59%) occurred in SJBP harvest areas and 552 (33%) in AP and NAP harvest areas. Collectively 92% of SJBP recoveries are currently in areas under migrant population hunting regulations. South Carolina's SJBP zone has been closed to hunting to protect wintering SJBP geese and the remainder of the state has a regular resident goose hunting season similar to that in place in Georgia and Florida. States with less than 25 SJBP recoveries were excluded from consideration as SJBP harvest areas. SJBP harvest zones were delineated from these band recovery data and are presented in Figure 1. SJBP hunting regulations will apply to these areas. The Pymatuning zone in Pennsylvania is recognized as a core SJBP area in the Atlantic Flyway with more restrictive hunting regulations than SJBP areas in New York, Virginia, and North Carolina. The Santee and Carolina Sandhills NWR (SJBP zone) in South Carolina are currently closed to Canada goose hunting.

Table E1. Summary of SJBP band recoveries (shot or found dead) in the Atlantic Flyway 1950-2001 hunting seasons, within proposed SJBP, RP and current AP or NAP harvest zones. Shaded areas are states with SJBP harvest zones.

State	Total SJBP recoveries	No in SJBP zone	No in AP or NAP zone	No in RP zone	No in AP, NAP or SJBP zones	% of SJBP recoveries in AP, NAP or SJBP zones
ME	1	NA[1]	1		1	100
NH	0	NA[1]	0			
VT	1	NA[1]	1		1	100
MA	4	NA[1]	4		4	100
RI	1	NA[1]	1		1	100
CT	0	NA[1]	0			
NY	159	26	127	6	153	96.2
NJ	5	NA[1]	5		5	100
PA	922	847	21	54	868	94.1
DE	19	NA[1]	19		19	100
MD	199	NA[1]	194	5	194	97.5
VA	212	33	168	11	201	94.8
NC	81	55	11	15	66	81.5
SC	14	1	NA	13	1	NA[2]
WV	18	NA[1]	NA			0
Total	1636	962	552	104	1514	92.5

[1] NA – No SJBP zone proposed for this state (not required for states with <25 SJBP recoveries).

[2] NA – SC SJBP zone is closed to Canada goose hunting

Figure E1. SJBP Canada geese band recoveries (1950-2001 hunting seasons) and harvest areas in the Atlantic Flyway.